MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

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E. J. STONE, M.A., F.R.S., President, in the Chair.

Frederick C. Green, Woodside Cottage, Breightmet, near Bolton, Lancashire;

Alexander Hamilton Howe, M.D., Hullerhirst, Stevenston, Ayrshire:

The Rev. J. Calbraith Lunn, Warrenpoint, Co. Down, Ireland;

S. T. H. Saunders, M.A., Merchant Taylors' School, E.C.;

Edmund Johnson Spitta, L.R.C.P., Ivy House, Clapham Common, S.W.; and

William Henry Walmsley, 35 Limes Grove, Lewisham, S.E.,

were balloted for and duly elected Fellows of the Society.

Observation of the Transit of Venus 1882, *December* 6, *made at the Allegheny Observatory.* By Professor S. P. Langley.

(*Communicated by E. B. Knobel.*)

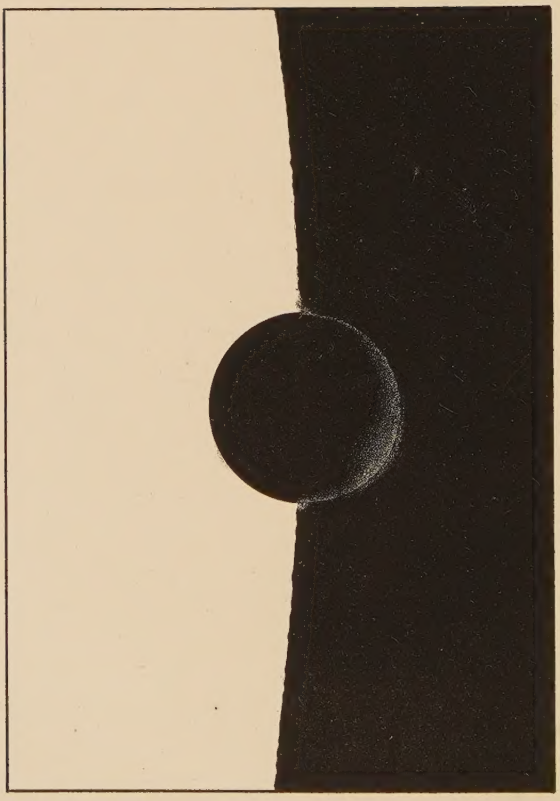
The observation of the Transit of *Venus* was so interrupted here by clouds yesterday that the times of contact have little value. A very unexpected and, I think, new phenomenon was noted however, connected with the luminosity about the planet, which deserves description in detail.

The telescope employed by the writer was the Equatorial of 13 inches aperture, temporarily limited to 6 inches, and used with a positive power of 244 upon the polarising solar eyepiece, which does not admit of a position circle.

The planet (whose first external contact was noted here at $20^h\ 44^m\ 15^s$, the first internal contact being at $21^h\ 5^m\ 0^s$) was seen through thin clouds which were passing incessantly over the Sun's face. At $20^h\ 47^m$, the part of the planet already on being conspicuous, the limb was boiling badly, and the anticipated ring of light around the exterior part of *Venus* was not visible. After an interruption, observation was resumed at about $20^h\ 53^m$, and a remarkable change was noticed. The planet was now nearly half entered on the disk, and still showed no uniform ring of light, but a very notable gathering of brightness, extending along some 30° of its southern and western circumference (outside the limb of the Sun). The centre of this bright marginal segment was estimated, from a rough sketch made at the telescope, as being about 30° on one side of a line joining the centres of the Sun and planet, and its asymmetrical position with reference to the horns of the solar crescent was conspicuous. The light was prolonged very faintly up to the Sun's edge on the western side, the eastern part of the planet being at this time scarcely yet distinguishable (as seen through the light haze) from its black background.

At $20^h\ 57^m$, after an interruption by clouds, the line of light could be followed all round, as described by previous observers, but the bright marginal enlargement of this ring remained unchanged. At $21^h\ 0^m$ (five minutes before internal contact) this bright spot was still visible. It was therefore watched by me, with occasional interruptions, for about seven minutes. Owing to the boiling of the limb, it was not easy to determine how much of this light lay without, how much within, the planet's contour. When first seen, it suggested for a moment the appearance of Baily's Beads, but the writer's very strong final impression was that it at any rate extended to some degree within the planet, and was brightest on the outside, with a slight gradation toward the planet's centre. Its greatest width was estimated at one-fourth of the planet's radius. Every precaution was taken against instrumental error. The spot was successively examined in different parts of the field, the eyepiece was rotated, and the amount of light from the reflectors was varied. It was beyond any question a real, if a most unexpected and unintelligible phenomenon, and it seems to me that it points to a real local cause on the planet. It does not appear to be at all assimilable to the concentric spots which some observers have believed they saw both on *Venus* and on *Mercury* in transit, nor to the alleged phosphorescence on the dark side.

At the same time Mr. J. E. Keeler, my assistant, using a telescope of only $2\frac{1}{4}$ inches aperture and a power of 70, independently observed and sketched the same phenomenon, though, owing to the size of his instrument, he appears not to have seen it in quite the same detail. He first saw it distinctly at $20^h\ 49^m\ 20^s$ (during the time in which the writer was called away from his own instrument), but had indistinctly noted it



Spot of light seen on Venus when entering on the Sun. 1882, December 6.
From a drawing by Prof. S. P. Langley.

W.H. Wesley lith. West, Newman & Co. imp.

fully a minute before, when he describes it as looking like a little star.

Mr. Keeler's impression was, that the light lay chiefly or wholly *outside* the planet's contour. His memorandum sketch made at the telescope places the brightest point 20° of the planet's circumference to the west of the line joining the centres of the Sun and *Venus*. He saw it at intervals for over eight minutes, and records it as still visible at $20^h\ 58^m\ 11^s$.

It will be seen that the two independent estimates differ from each other by 10° as to the spot's position. If we take their mean, and assume that the position-angle of the planet itself on the Sun at the time was 148°, we obtain 173° as the position-angle of the bright spot, a line through which and the planet's centre would, as it readily appears, make an apparent angle of 76° with the plane of the ecliptic. After internal contact the limb of *Venus* was spectroscopically examined for absorption lines, but without effect. Clouds put an end to these latter observations before any result was reached other than that if any such absorption exists it is inconspicuous in the regions near D.

A drawing copied from my own sketch of this very curious phenomenon is here given.

Allegheny Observatory, Pa.:
1882, *Dec.* 7.

Le passage de Vénus observé à l'Observatoire de Moncalieri.
Par le P. F. Denza.

Nous nous étions préparés à observer avec le plus grand soin possible les deux premiers contacts, extérieur et intérieur, et à faire l'une ou l'autre des observations raccomandées dans les instructions que l'Observatoire de Washington a publiées pour cette circonstance. Je dirai ici un mot de quelques-unes parmi les plus intéressantes.

Avant que le phénomène commençât, la partie occidentale du ciel, où se trouvait le soleil, fut encombrée de nuages stratiformes, qui, en devenant tantôt plus rares, tantôt plus denses, rendaient le bord solaire extrêmement agité, et par suite rendaient l'observation incertaine. Et cette portion du ciel se maintint dans cet état jusqu'au coucher du soleil.

Ce fut pour cela que nous dûmes renoncer à quelques observations spectroscopiques, que nous nous étions proposé de faire. Par contre, nous nous occupâmes à déterminer avec la plus grande attention qu'il nous fut possible, les instants des deux contacts. J'observais au réfracteur de Merz de 4 pouces d'ouverture. Le grossissement employé fut 54 pour le contact extérieur, et de 120 pour le contact intérieur.

Voici les résultats que nous avons obtenus :

	h	m	s	
Premier contact extérieur	2	49	31·0	temps moyen de Rome.
„ intérieur	3	9	54·4	

L'instant du contact intérieur passé, lorsque le disque obscure de *Vénus* s'était déjà détaché du contour solaire, on vit assez bien encore uni à ce dernier au moyen de la *goutte noire.*

Selon nos déterminations, ce ligament se détacha complètement à $3^h\ 10^m\ 37^s{\cdot}8$.

Je fus attentif à observer si, après le contact extérieur, on distinguait autour du disque de la planète l'auréole de lumière, indice de l'atmosphère de *Vénus*, éclairée par le soleil ; mais je ne pus rien découvrir, pas même sur la portion du contour plus rapprochée du soleil, l'air étant toujours voilé et quelque peu agité.

Le disque de *Vénus* n'apparut entièrement noir ; il avait une teinte entre le rouge faible et le jaune sombre, le contour oscillant, à cause de la trop grande quantité de vapeur, dont l'influence allait toujours en augmentant à mesure que le soleil s'approchait de l'horizon.

C'est pour cela que les déterminations du diamètre de la planète ($67''{\cdot}12$), que nous avons prises, ne sont pas trop sûres.

De l'Observatoire de Moncalieri :
1882, 8 *Décembre.*

Observation of the Transit of Venus 1882, *December* 6.
By the Rev. R. P. Davies.

As so very many observers in England were prevented from seeing anything of the Transit in consequence of an overcast sky, and others missed the contacts through cloud, I venture to send the following, having been exceptionally well favoured. From two or three minutes before external to some considerable time after internal contact there was nothing to mar the view. No attempt was made to note the time of external contact, the image of the Sun being thrown upon a screen in order that a party of friends might see the advance of the planet upon the disc at the same time. After the lapse of about twelve or fifteen minutes, a first surface reflecting prism, negative eyepiece, and neutral-tint glass shade were affixed, and I was left in the Observatory alone with only an attendant to watch and count the clock. There were thus about five or six minutes to follow the planet to internal contact. The attention was especially arrested by the aureole with its delicate tint. As the time of internal contact approached there was a phase at which it seemed well to mark the *second*, as it might turn out to be that which

answered best to the requirements of the "Instructions," p. 3, under "At Ingress." Nevertheless I felt satisfied that it was not contact, and that the appearance was still partly due to the light refracted through the planet's atmosphere. Nine seconds afterwards there was an unmistakable junction of the cusps of the Sun's surface; or, as I find it in my notes, written on the day and not touched since, "strip of sunlight unmistakable." This was at local sidereal time $19^h\ 16^m\ 4^s$, which when converted into G.M.T. (the longitude being $7^m\ 6^s{\cdot}2$ W.) gives $2^h\ 22^m\ 6^s{\cdot}32$.

There was but a very little distortion of the planet's form, and very little of the black drop; a striking contrast with that which baffled me when observing the egress of *Mercury* in the transit of November 1868. After the time noted, and probably after returning from the clock, I observed a faint fine line, "like a cobweb for fineness," connecting the planet with the limb of the Sun, the planet being then well on the disc. I regret to say that the moment when this disappeared was not noted.

The telescope is equatorially mounted and driven by a clock: its aperture, 4 inches; the power used, 60. The latitude and longitude of my Observatory are $51°\ 44'\ 40''$ N., $1°\ 46'\ 32''{\cdot}5$ W.

Hatherop Rectory, Fairford, Gloucestershire:
1883, *Jan.* 9.

Observation of the Transit of Venus 1882, *December* 6, *made at Marseilles.* By the Rev. S. J. Johnson.

I observed the Transit from an upper window in the Hôtel Louvre et de la Paix in the city of Marseilles, having obtained time from the Observatory. The only instrument at my disposal was a $2\frac{1}{4}$-inch telescope by Cooke. At the time of internal contact the Sun was visible through light clouds. No higher power than 70 could be employed, and no dark glass was necessary. At $2^h\ 39^m\ 47^s$ (local time) the limbs seemed in contact, but actual sunlight did not appear round the planet until $2^h\ 42^m\ 36^s$ (local time), somewhat suddenly. This would probably be true internal contact. At $2^h\ 46^m$ the Sun shone out brighter, and a power of 150 showed *Venus* well defined, and without the least trace of any ring of light. Through a darkened glass the planet was distinctly visible to the naked eye (and was so seen by numbers of persons at Bridport). After $3^h\ 18^m$ the planet began to boil, and after $3^h\ 22^m$ the clouds thickened.

Melplash Vicarage, Bridport:
1883, *Jan.* 8.

Observation of the Transit of Venus 1882, *December* 6, *made at Fernhill, Wootton Bridge, Isle of Wight.* By Frederick Brodie.

So few persons in England seem to have had a view of this Transit, that I send a few remarks on the little that was visible here.

The whole period of the Transit visible in these latitudes was more or less obscured by clouds. The external contact was not seen, but at $2^h\ 3^m$ L.M.T. the planet was seen partly on the Sun's disk. The internal contact took place between $19^h\ 18^m$ and $19^h\ 18^m\ 6^s$ L.S.T. It was quite impossible to obtain any exact observation, as the great amount of aqueous vapour that was passing made the definition of the disks of planet and Sun of maximum unsteadiness. It could hardly be worse. I was using a power of 80 on the $8\frac{1}{2}$ in. Equatorial, and generally only with a dark glass used as a moonshade, so seldom was the Sun free from cloud more or less.

When the planet's disk was about half way on the Sun's periphery, I got a short view, showing me with great clearness the twilight caused by the atmosphere of *Venus* all round that portion of her disk as yet off the Sun. It was a soft white light, assuming a ruddy hue next to the edge of the planet's disk. The effect of it was beautiful, and this continued nearly until the time of internal contact. It was at once evident that the extent of the atmosphere round the planet was infinitely greater than that accorded to our own planet. This was also clearly seen in a telescope by Merz of 3 in. aperture that my son was using.

After the planet was on the Sun's disk about an hour, the southern half of the planet's disk was fringed with an intense blue colour, and the northern half of the disk with a reddish orange. This effect was also clearly seen in the 3 in. Merz telescope. This was not due to the position of the planet in the field of the eyepiece, as is often the case in a lesser degree, but was, apparently on account of the low elevation, in a bad state of atmosphere. The longest continuous view I had was not more than two or three minutes on the one occasion of internal contact; at other times I only had glimpses of much shorter duration.

The observation was made with an Equatorial of $8\frac{1}{2}$-inch aperture by Cooke & Sons.

Observations of the Solar Spots of November 1882.
By Frederick Brodie.

The large solar spots, concerning which notes were given by Messrs. Howlett and Pratt in the *Monthly Notices* for May last, have, I think, been surpassed in size by those of November.

The huge crater, or *penumbra*, in which these spots, or *umbræ*, were situated, was the largest that I remember to have seen, and far larger than that which occurred in October 1865, which was mentioned then in the *Notices* of the R.A.S. by the Rev. F. Howlett and myself, and which was especially interesting on account of the extreme rapidity of the photospheric changes.

November 15.—The spot now visible on the Sun is an immense size. The *penumbra* is of an irregular oval shape, and measures across its major axis 128″, equal to 56,000 miles; while its minor axis measures 116″, or 51,000 miles. The *umbra* is most irregular in shape, measuring in its greatest length 39,000 miles, and its greatest breadth 23,000 miles. The changes in its outline are very rapid, so much so that it is most difficult to sketch, in addition to which the low altitude of the Sun and correspondingly bad definition render it increasingly difficult. The *umbra* has six large and long promontories stretching more or less across it, something like the fingers of the hand, only that they are curvilinear. The rugged glacier-like form of the sides of the *penumbra* is most remarkable, but the atmosphere is too bad to make measurements of details.

Clouds prevented further observation for some days.

November 19.—The great spot has greatly altered in its details. There is now a nest of *umbræ* within the one *penumbra*, which has not materially altered in shape, though it is enlarged, its greater length now being 64,000 miles, and its breadth 52,000 miles. The extreme activity of the photosphere continues, and is far greater than what I have ever noticed before. Within three hours two of the larger *umbræ* had joined themselves together, and had again separated. The channel of communication between them that was opened and again filled up was roughly estimated at about 2,000 miles wide and 8,000 or 9,000 miles long.

The extremely bad definition and the unsteadiness of atmosphere render it impossible to observe or measure the small details, while the excessively cloudy weather prevents anything more than occasional views of the Sun, otherwise this spot would have formed a study of surpassing interest.

The instrument employed was an Equatorial of 8½ in. aperture by Cooke & Sons.

The Spectrum of the Great Sun-spot of 1882, *November* 12–25, *observed at the Royal Observatory, Greenwich.*

(*Communicated by the Astronomer Royal.*)

The spectrum of this remarkable spot was examined by means of the "half-prism" spectroscope on three occasions, viz., Nov. 18, 20, and 21. The weather in each instance was very unfavourable for a satisfactory examination, being misty and cloudy on Nov. 18 and 20, and on Nov. 21 the Sun was only visible

through a yellow fog. A detailed examination of any but the most conspicuous lines was therefore out of the question.

Nov. $17^d\ 23^h$–$18^d\ 1^h$.—The following lines were observed to be reversed, *i.e.*, bright instead of dark over the principal nucleus of the spot:—C, D_1, D_2, D_3, and F. Of these, C and F were exceedingly bright, particularly F; and this, notwithstanding that the mist enfeebled the blue and violet portions of the spectrum. D_3 was only perceived for a short time, apparently when the mist was lightest, about $23^h\ 50^m$. D_1 and D_2 were not only reversed but extravagantly broadened, each line forming a very broad and ill-defined dark band, quite 6 tenthmetres in breadth, with a sharp, narrow, bright line in the centre, apparently at the normal place of the line. This appearance, and the reversal of D_3, were noticed whenever the definition and light were a little better than usual. The reversal of C and F took place over the bright tongue, which all but divided the largest nucleus of the spot into two nearly equal portions. The reversal of the sodium lines was not noticed at the point where C and F were brightest.

The third and fourth lines of hydrogen could not be detected, but the mist made it impossible to observe the extreme ends of the spectrum.

The *b* lines and 1474 K showed no appreciable change. The strong calcium lines between C and D were doubled in breadth. The E lines were less strongly affected, and were perhaps one-third as broad again as usual.

The *general* absorption of the spot was small: that is, the continuous spectrum was not so much fainter than that of the general disk as might have been expected.

Nov. $19^d\ 23^h$–$20^d\ 0^h$.—The *general* absorption was more marked than on Nov. 18, and more lines were noticed to be broadened. The general absorption was not, however, uniform; here and there, there were broad, ill-defined patches, noticeably darker than the rest of the spectrum. The district lying between λ 4900 and λ 4830 was one of the most marked of these.

The C line was seen reversed right across the great nucleus; D_3 and F were suspected to be reversed, but, owing to the mist, could not be clearly seen as bright lines. D_1 and D_2 also could not be seen as bright lines, but they presented exactly the same appearance as they had done on Nov. 18, at times when the mist was too dense to permit the reversal to be clearly seen. That is, they were very much broadened, were very ill-defined, and much fainter than usual in the middle. Several other lines, amongst them λ 4957, λ 4920, and λ 4918, closely resembled the D lines. The 1474 K line did not appear to be affected, but one near it, either λ 5301 or λ 5307,—there was not time to properly identify the line, but it was believed to be λ 5307,—vanished over the spot.

The calcium and iron lines between C and D were much broadened, and also those near λ 5600 and λ 5856. These were broader by about two-thirds; the E lines were broader by about

one-half, the *b* lines by one-quarter. All these lines were, as a rule, well-defined, that is to say, they did not show the "smudged" appearance seen in the D lines, and the three iron lines near F, mentioned above.

The foregoing observations, both on Nov. 18 and 20, were all made with the "half-prism" spectroscope reversed, that is, with the instrument arranged as for observation of the prominences, so as to give great purity. Two "half-prisms" were employed. The spectroscope was afterwards placed in the direct position, as used for observation of stellar spectra, and only one "half-prism" was employed. With this dispersion, a remarkable reversion of the F line was noticed. At the preceding edge of the great nucleus, there was a broad bright flame, which, touching the F line at the extreme preceding edge of the nucleus, sloped away from the nucleus in the preceding direction, and from the F line towards the blue. It was inclined to the F line at an angle of about 40°, was 1 or perhaps $1\frac{1}{4}$ tenthmetre in average breadth, and extended to a distance from the F line of 3 or perhaps $3\frac{1}{2}$ tenthmetres. It was pointed at each end, and was nearly but not quite straight, being a little twisted near its centre. A displacement of $3\frac{1}{2}$ tenthmetres towards the blue would correspond to a motion of approach of 134 miles per second. Time of observation Nov. $19^{d}\ 23^{h}\ 20^{m}$.

Nov. 21.—The sun was only seen through fog and was very faint. The spot-spectrum was therefore a dense black band in which it was very difficult to perceive any details. The "half-prism" spectroscope reversed, with two "half-prisms," was used throughout the morning. The C and F lines were reversed over the greater portion of the area of the spot, not, however, over the very darkest part of the principal nucleus, but over all its fainter portions. D_3 and perhaps 1474 K seemed to be reversed over the same region. The latter line seemed to be displaced nearly 1 tenthmetre towards the red. The D lines together covered quite 10 tenthmetres, and ran one into the other; they were very ill-defined, and appeared exactly as on Nov. 20. They extended further towards the blue than towards the red, in fact, the broadening seemed traceable twice as far in the first direction as in the second. A very large percentage of the lines between D and F had a similar appearance to that shown by the D lines and the iron lines near F on Nov. 20; *i.e.*, they were very much broader than on the general disk, were very ill-defined, and were much fainter than the corresponding lines on the Sun, especially about their centres. It is, therefore, probable that a clearer day would have shown them as distinctly reversed, especially as the F line showed precisely the same "smudged" appearance whenever the fog became too thick for it to be seen as a bright line.

Group *a* and the lines at λ 6200 were very much broadened, principally on the side nearer the blue.

A momentary gleam of clearer sunlight showed F reversed in the most intricate and beautiful manner right across the great

nucleus—not over its entire area, but at short intervals from one side to the other, even over its blackest portion. These stars of brilliant blue light were on the average about twice as broad as the dark F line on the general disk, sometimes four times as broad, and were but little displaced, if at all.

The observations were made by Mr. Maunder throughout.

Royal Observatory, Greenwich:
1883, *Jan.* 12.

Spectroscopic Results for the Motions of Stars in the Line of Sight, obtained at the Royal Observatory, Greenwich, in the Year 1882. No. VI.

(*Communicated by the Astronomer Royal.*)

The results here given are in continuation of those printed in the *Monthly Notices*, vol. xxxvi. p. 318, vol. xxxvii. p. 22, vol. xxxviii. p. 493, vol. xli. p. 109, and vol. xlii. p. 230. The observations were made with the "half-prism" spectroscope, one "half-prism" with a dispersion of about $18\frac{1}{2}°$ from A to H being used. An eyepiece with a magnifying power of 14 was employed throughout.

Up to 1882, March 13, a convex cylindrical lens, with its axis parallel to the length of the spectrum, and placed in the view-telescope within the focus, and a concave or Barlow lens of 2 inches focus placed in the collimator between the slit and the object-glass, as used throughout the year 1881, were employed. On March 14, the Barlow lens was removed, and the cylindrical lens was placed in front of the slit, as in the observations made previously to 1881. In most of the observations a diaphragm coated with Balmain's luminous paint has been used in the micrometer-adapter to give a phosphorescent illumination of the field.

The observations of the Moon and of the sky spectrum have been made as a check on the general accuracy of the results.

Motions of Stars in the Line of Sight, in Miles per Second, observed with the Half-prism Spectroscope.

(+ denotes Recession; − Approach.)

The initials M. and N. are those of Mr. Maunder and Mr. Nash respectively.

Date.	No. Obs.	of Line. Meas.	Earth's Motion in M. per sec.	Concluded Motion of Stars. Meas.	Estimd.	Remarks.
			β Cassiopeiæ.			
1882.						
July 24	M	2 F	−11·2	+34·1	+33·9	Clouds constantly passing. Observation unsatisfactory.

Date.	Obs.	No. of Line. Meas.		Earth's Motion in M. per sec.	Concluded Motion of Stars. Meas.	Estimd.	Remarks.
				γ Pegasi.			
1882							
Nov. 9	M	2	F	+11·8	−41·1	−39·6	Definition poor.
				β Persei.			
Nov. 9	M	2	F	− 2·1	+18·1	+17·3	Definition fair.
				α Persei.			
Nov. 8	N	1	F	− 4·2	−30·2	−30·3	Definition good.
				Capella.			
Oct. 20	N	2	b_1	−13·7	+33·4	+28·2	Observation unsatisfactory.
Nov. 9	M	2	F	− 9·3	+22·5	+22·6	Definition fair.
10	N	2	F	− 9·1	+19·9	+24·8	„ good.
				γ Orionis.			
Feb. 10	M	3	F	+16·0	+8·5	+ 5·4	Cloud passing. Measures made with difficulty.
				β Tauri.			
Feb. 10	M	3	F	+16·4	−34·0	−31·3	Definition good.
				γ Geminorum.			
Mar. 14	M	4	F	+18·0	−26·4	−27·4	Definition poor.
				Sirius.			
Feb. 10	M	6	F	+ 9·3	− 1·7	− 3·3	Definition good.
Mar. 14	M	5	F	+13·6	+ 0·7	+ 6·4	Definition good.
Apr. 5	M	3	F	+14·1	+10·9	+15·4	„ fair.
8	M	6	F	+14·0	+ 8·2	+ 8·9	„ good.
				Castor.			
Feb. 10	M	4	F	+10·3	+19·9	+15·3	Definition fair.
Mar. 14	M	3	F	+16·7	+ 8·5	+18·0	„
Apr. 5	M	2	F	+18·0	+22·5	+24·4	„
				Procyon.			
Feb. 10	M	2	F	+ 8·5	+27·6	+24·1	Definition good.
Mar. 14	M	4	F	+15·5	+ 3·2	+ 9·3	Definition fair.
Apr. 5	M	2	F	+17·4	+18·8	+21·5	„
				Pollux.			
Feb. 10	M	4	F	+ 9·3	−14·4	−12·1	Definition good.
Mar. 14	M	2	F	+16·3	−40·3	−43·6	„ poor.

Date.	No. Obs.	of Line. Meas.		Earth's Motion in M. per sec.	Concluded Motion of Stars. Meas.	Estimd.	Remarks.
				δ Leonis.			
1882.							
Apr. 8	M	2	F	+11·2	−35·0	−35·5	Definition fair. Spectrum steady.
				θ Leonis.			
Apr. 8	M	3	F	+10·9	+ 5·7	+ 4·0	Star-line broad and faint.
				α Virginis.			
Apr. 8	M	4	F	− 0·1	−21·2	−22·3	Spectrum bright, but tremulous.
				Arcturus.			
June 12	M	2	F	+13·2	−30·4	−28·6	Definition good.
Aug. 8	M	2	b_1	+14·1	−54·8	−69·1	„ poor.
	N	1	b_1	+14·1	−53·9	−69·1	
				β Libræ.			
June 12	M	2	F	+ 9·9	−37·5	−38·7	Spectrum very faint.
				α Coronæ.			
Apr. 8	M	2	F	− 4·8	+18·8	+21·6	Definition poor.
June 14	M	4	F	+ 8·7	+41·2	+35·5	„ good.
				α Ophiuchi.			
June 14	M	4	F	− 0·8	+31·6	+28·7	Definition fair.
July 10	M	2	F	+ 6·7	−41·2	−45·2	Definition good, but spectrum faint.
				γ Draconis.			
Aug. 21	M	2	b_1	+ 4·2	− 9·0	−10·2	Wind high. Definition poor.
				α Lyræ.			
June 14	M	2	F	− 2·9	−26·7	−27·9	Definition good.
July 29	M	2	F	+ 3·3	−42·0	−45·0	Spectrum fairly steady.
Aug. 4	M	2	F	+ 4·1	−34·5	−28·8	Definition good.
Nov. 8	N	4	F	+ 7·5	−53·2	−46 4	Spectrum very bright.
				ζ Aquilæ.			
Aug. 2	M	2	F	+ 5·5	−20·1	−21·8	Spectrum faint. Observation unsatisfactory.
				β Cygni.			
Aug. 21	M	4	b_1	+ 5·8	−28·2	−34·2	Wind high. Definition very poor.

Date.	No. Obs.	Line.	Meas.		Earth's Motion in M. per sec.	Concluded Motion of Stars. Meas.	Estimd.	Remarks.
					γ Aquilæ.			
1882.								
Aug. 8	M	2	b_1		+ 4·5	−21·8	−20·9	Definition good.
	N	1	b_1		+ 4·5	−16·0	−4·5	
					α Aquilæ.			
June 14	M	4	F		− 9·2	−22·2	−18·3	Definition good.
July 12	M	2	F		− 2·6	−33·3	−41·1	Spectrum faint. Cloud forming.
Aug. 2	M	2	F		+ 2·8	+13·1	+16·7	Definition good.
					γ Cygni.			
Aug. 21	M	2	b_1		+ 1·0	−16·1	−21·0	Wind high. Definition poor.
					α Delphini.			
Aug. 2	M	2	F		− 1·4	−10·9	−11·6	Spectrum faint. Observation unsatisfactory.
					α Cygni.			
July 15	M	2	F		− 5·8	−28·2	−30·9	Definition variable.
Aug. 4	M	2	F		− 3·2	−17·0	−17·4	„ good.
	N	2	F		− 3·2	−16·6	−16·0	
Aug. 21	M	2	b_1		− 0·8	−31·0	−49·1	Wind high. Definition fair.
Oct. 7	M	2	b_1		+ 6·0	−42·2	−53·9	Spectrum faint, owing to mist, but steady.
					ζ Cygni.			
Aug. 21	M	2	b_1		− 0·6	+ 0·8	+ 0·6	Definition poor.
					η Pegasi.			
Aug. 8	N	2	b_1		− 9·0	+ 1·2	+ 0·8	Definition fair.
	M	2	b_1		− 9·0	+ 9·5	+ 9·0	
					α Pegasi.			
July 24	M	2	F		−12·8	−13·3	−18·7	Clouds passing. Observation unsatisfactory.
Aug. 2	M	2	F		−11·1	− 8·9	− 9·8	Definition good.
Nov. 9	M	4	F		+14·6	−46·7	−43·0	Definition very poor.
					Moon.			
July 29	M	5	F			− 3·0		Moon spectrum faint. Definition fair.
Aug. 2	M	5	F			+ 2·6		

Date.	No. Obs.	of Meas.	Line.	Earth's Motion in M. per sec.	Concluded Motion of Stars. Meas.	Estimd.	Remarks.
1882.					*Sky Spectrum.*		
Feb. 11	M	5	F		+ 1·2		Hydrogen spectrum faint; comparison difficult.
Mar. 14	M	5	F		+ 2·7		
Apr. 6	M	5	F		− 3·9		

Royal Observatory, Greenwich:
1883, *Jan.* 12.

Observation of the Great Comet (b) 1882, *made with the Transit Circle at the Royal Observatory, Greenwich.*

(*Communicated by the Astronomer Royal.*)

	Greenwich Mean Solar Time.	Observer.	R.A.	N. P. D. (Corrected for Refraction and Parallax.)
1882.	h m s		h m s	° ′ ″
Nov. 26	16 37 31	A.D.	9 1 29·93	117 46 39·59

Comet very faint; appeared elongated in a direction inclined 45° to the parallel of declination. The brightest part at about one-third of the way from the north end of the elongation to the south was observed.

Royal Observatory, Greenwich.
1883, *Jan.* 12.

Observations of the Great Comet (b) 1882.
By Charles Leeson Prince.

The Society has doubtless received, and will continue to receive, many details of the appearance of the great comet which has lately visited our region in space, and as the weather during the month of October, which was the most important period for making good observations in England, was extremely unfavourable, I beg to forward to the Society a few notes of what I was able to record at my Observatory upon the only possible opportunities. My first view of the stranger was at 5 A.M. on Oct. 4, and my first impression was that its general aspect was grander than that of Donati's in 1858, and exceeded in brilliancy of detail the great comet of 1861. As the nucleus was much enveloped in a mist which lay along the horizon, it was not very well defined in the telescope, but appeared to be oval, or pear-shaped, of a diffused orange colour, and without any very definite appendage surrounding it. The tail was nearly 25° long, and of great breadth at its extremity. I had no further opportunity of seeing it again until the morning of the 10th, when it was decidedly brighter than on the 4th; but this effect might have been partly due to my time of observation having been somewhat earlier.

The tail, at its extremity, had a brilliant silvery light, and a peculiar flocculent appearance, against the dark sky. It extended nearly to *a Hydræ*. A few small stars were visible through it without, I think, having their brightness diminished. To the naked eye, I thought the brightness of the nucleus was about equal to that of a star of the second magnitude. On account of clouds coming up from SE. I had very little time for observation this morning.

Oct. 13.—I saw the comet again this morning, for a short time, but the definition was very unsatisfactory on account of the disturbed condition of the atmosphere. I could notice, however, that there was a decided change in the appearance of the nucleus. Instead of being of an oval shape it had become a long flickering column of light in the direction of the tail. The comet was very impatient of daylight, and could not be seen in the telescope after sunrise.

Oct. 20.—On account of the presence of clouds I did not see the comet this morning until the dawn had considerably advanced. I noticed, however, at once, that a still further change had occurred in the nucleus since the 13th, which amounted, in fact, to its disruption into at least three portions. Unfortunately, the definition was much interrupted by a thin layer of cirrostratus cloud. The brightest portion was the central one, and the column of light, seen on the 13th, had become narrower as well as lengthened in the direction of the tail. The southernmost portion was extremely faint and required some attention to be seen at all.

Oct. 23.—I had a splendid view of the comet this morning at $4^{h}\ 30^{m}$ L.M.T., and the definition was extremely good. I thought that both the nucleus and tail had somewhat diminished in brilliancy. The former was still visible to the naked eye as a star of about the fifth magnitude. The length of the tail was was fully 20°. The disruption of the nucleus which I had noticed on the 20th was now fully apparent. The nucleus proper had become quite linear, having upon it the four distinct points of condensation which I have endeavoured to represent in the subjoined sketch.

It must be understood that the accompanying woodcut is to be considered rather as a *diagram* of the head of the comet than as a *view* of what I actually observed, and that the *points* in question are somewhat exaggerated in size, as well as the linear character of the nucleus itself. I found it was very difficult to represent, by means of a wood block, such a nebulous object; but I think it will serve to illustrate the nature of the wonderful disruption, and the relative distance of the several portions *inter se*: *a* was the most difficult portion to discern; *b* was by far the brightest of all; *c* was considerably less bright than *b*; and *d* was nearly as faint an object as *a*, and not quite so large. The linear nucleus, with these points of condensation upon it, was surrounded by a distinct oblong coma, which was rounded off at the lower extremity, while the upper portion, following the direction of the tail, terminated more decidedly in a point. G. J. Symons, Esq., F.R.S., was with me in the Observatory, and his impression was that there were *five* points of condensation, and he remarked that "the nucleus was like a string of beads." At intervals I thought there *was* another point of light between *b* and *c*, but as I could not absolutely satisfy myself of its objective existence, I have only represented the four portions, of the presence of which I entertained no doubt whatever. Both Mr. Symons and myself particularly noticed the frequent flickering of the light of the nucleus, which was quite apparent both to the naked eye and in the telescope.

Oct. 30.—After the lapse of a week I had another opportunity of observing the comet, but found that the presence of moonlight considerably diminished its brightness. The nucleus was, however, quite visible to the naked eye, and shone brightly in a large opera-glass. The almost saturated condition of the atmosphere prevented any good definition being obtained by the telescope. The largest point of condensation still shone brightly, but the three smaller portions were scarcely visible—in fact, *a* could no longer be seen. The nucleus maintained its strictly linear form, but all its more interesting features were much less distinct. With respect to the general appearance of the tail, there was a dark, nearly central, space throughout its entire length, the southern side being the brighter of the two, more particularly midway its length. On the morning of the 10th it was curiously bifurcated, near to its extremity, and had somewhat the appearance of entangled bright cords, or scattered locks of wool.

These observations were made with my Tulley Equatorial of 6·8 inches aperture and 12 feet focal length; powers 30 and 80.

The Observatory, Crowborough:
1883, *Jan.* 2.

Sextant Observations of the Great Comet (b) 1882, *taken on board the ship "Earnock," on a passage from Glasgow to Melbourne.* By Capt. G. F. Parson.

(*Communicated by Capt. Henry Toynbee, R.N.*)

Date. 1882.	App. Time Ship. A.M. h m	Lat. S. ° ′	Long. W. ° ′	Obs. Alt. ° ′ ″	Sirius. ° ′	Distances from Canopus. ° ′	α Crucis. ° ′	Remarks.
1882, Sept. 22	5 38	22 20	26 50	6 56 30	—	—	—	
24	5 10	28 42	26 52	—	64 47	74 54	—	Stars more at a right angle would have been used, but daylight rendered these the only available ones, owing to their brilliancy.
	5 21	,,	,,	7 20 0	—	—	—	
25	5 11	32 14	25 6	—	63 51	74 10	—	The body of the comet apparently equal to a star of the 1st magnitude.
		,,	,,	7 0 0	—	—	—	
28	5 6	39 20	13 46	—	61 34	71 43	—	Very brilliant.
		,,	,,	11 4 0	—	—	—	
29	4 51	40 7	11 20	—	60 52	—	—	
Not seen again until		,,	,,	—	—	70 57	—	
			E.					
Oct. 13	3 29	43 7	34 36	—	54 6	62 37	—	A good view; tail visible 19½° towards Orion's belt.
14	4 21	43 8	40 28	—	53 41	61 56	—	
Only an occasional glimpse until								
Oct. 24	3 13	41 21	84 25	—	49 50	57	—	
	3 20	,,	,,	21 26	—	—	51 20	Tail visible 17° towards Rigel.
31	2 20	40 30	113 5	—	47 11	53 19	—	Moon rather bright for good observations.
Nov. 2	3 39	40 37	123 29	—	46 30	52 48	—	
7	2 4	38 40	139 50	—	44 29	49 58	48 9	Tail 17½°.

Sextant Observations of the Great Comet (b) 1882, *made on board the ship "Superb."* By Capt. D. W. Barker.

(*Communicated by Capt. Henry Toynbee, R.N.*)

Date.	Lat. S	Long. W.	Stars used.	Distance from Comet.	Time by Chronometer G. M. T.	Remarks.
	° ′	° ′		° ′ ″	d h m s	
1882, Sept. 28	49 19	173 13	α Crucis	59 18 33	28 3 55 47	Tail about 9½° long. Bright clear morning.
			Canopus	71 13 8	3 57 0	
			Procyon	49 34 8	4 0 21	
Oct. 1	48 47	158 53	α Crucis	58 13 3	1 3 4 23	Tail about 11° long. Brightness comparable with α Orionis. Bright clear morning.
			Canopus	69 10 58	3 6 3	
			Sirius	59 24 23	3 7 38	
4	48 7	152 30	Sirius	57 47 44	4 2 47 51	More or less cloudy. Tail longer and less bright.
			Canopus	67 16 8	2 43 8	
5	48 26	150 46	α Centauri	67 24 59	5 1 16 15	Passing clouds. Tail extending directly towards α Hydræ, almost reaching it. Less bright.
			Canopus	66 39 59	1 17 38	
			Sirius	57 16 59	1 31 33	
13	50 48	112 41	Canopus	62 16 29	12 23 36 25	Tail getting fainter and longer. Fine and clear weather.
			Sirius	53 0 29	23 38 54	
30	45 56	45 14	β Centauri	58 25 25	29 17 3 12	Bright clear weather. Much fainter than when last observed.
			Canopus	53 42 45	17 12 35	

Date.	Lat. S.	Long. W.	Stars used.	Distance from Comet.	Time by Chronometer G. M. T.	Remarks.
	° ′	° ′		° ′ ″	d h m s	
1882, Oct. 30	45 56	45 14	Sirius	47 22 45	17 16 48	
Nov. 5	34 18	35 5	β Centauri	57 53 0	4 15 54 38	
			Canopus	50 4 40	15 53 6	Clear weather.
			Sirius	45 0 0	15 48 25	
8	31 29	31 5	Canopus	43 23 35	7 15 49 44	Tail 17½° long. A splendid object. Tail broader, nucleus fainter. Passing clouds.
			Achernar	49 4 40	51 29	
			α Crucis	48 16 0	53 38	
14	21 33	29 56	Canopus	45 13 10	13 18 7 26	
			α Centauri	61 42 15	9 25	Passing clouds, otherwise clear.
			Sirius	40 58 15	10 46	
	N.					
Dec. 7	20 20	36 15	Alphard	24 27 15	6 18 38 33	Fine and clear. A much fainter object Nucleus situated about 1° W. of *f* Mali; tail to 16 Puppis.
			Sirius	28 51 10	42 52	
			Procyon	37 56 45	44 35	
9	25 50	37 23	Sirius	27 34 55	8 19 14 52	Passing clouds.
			Procyon	37 46 45	17 8	
			α Hydræ	25 25 55	21 41	

Observations of the Great Comet (b) 1882, *made at Dalston, London, E.* By B. J. Hopkins.

(*Communicated by the Earl of Crawford.*)

The instrument with which the following observations were made is a refractor of five inches aperture. The full aperture, and a Ramsden eyepiece having a power of 107, was always used.

1882, *Nov.* 4, $17^h\ 0^m$.—The tail had an apparent length of 20°, and a breadth at the extreme end of 1° 30′. It slightly curved upwards, was very diffused at the end, and was divided into two portions by a dark rift for two-thirds of its length from the nucleus.

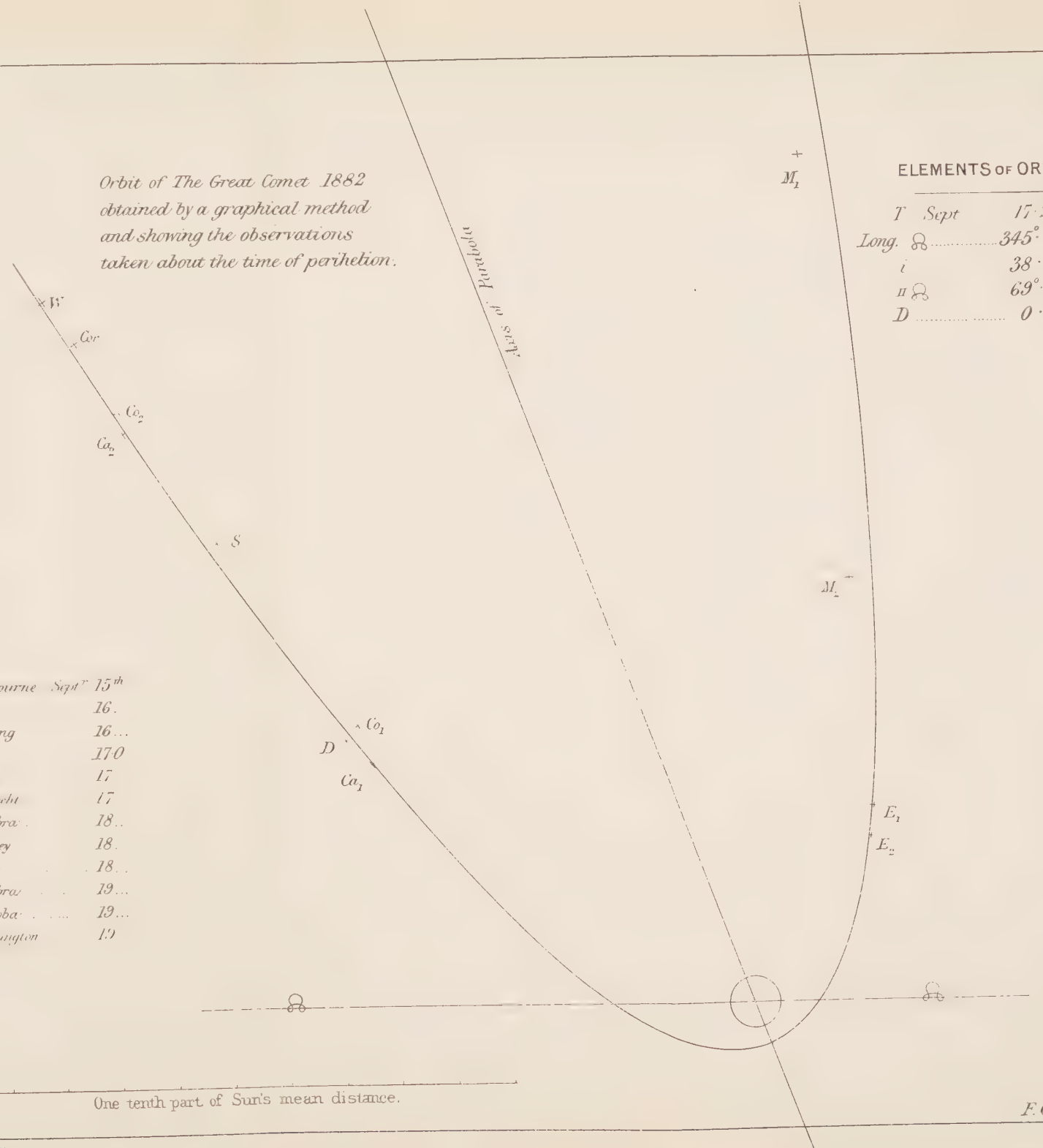
Nov. 4, $17^h\ 50^m$.—The nucleus was of a yellowish-white colour, oval in shape, with the major-axis in the direction of the tail, and surrounded with a dense nebulosity.

Nov. 8, $16^h\ 50^m$.—The tail could be distinctly traced for 19°. It was straight for four-fifths its length. It then abruptly curved upwards, and spread itself out in the shape of a fan, with a breadth of 4°. The dark rift was not so conspicuous as on the 4th inst., though the tail still remained brightest on the southern side.

Nov. 8, $17^h\ 30^m$.—The nucleus, as viewed by the naked eye, appeared equal to a second magnitude star. Observed with the telescope, a great change was seen to have taken place since last observed, for it now had the appearance of being double, there being two portions of equal brightness separated by a space of less brightness, the whole being surrounded by a dense circular nebulosity. The division between the two portions was only just seen, and the line joining them was at an angle with the axis of the tail.

Nov. 14, $15^h\ 45^m$.—The tail I now saw to much better advantage than I had hitherto observed it. It had a length of 30°, and was divided into two portions at the extreme end, the northern half curving very sharply upwards as in the figure, and separated from the southern branch by a semicircular space,

Orbit of The Great Comet 1882
obtained by a graphical method
and showing the observations
taken about the time of perihelion.



M_1	Melbourne	Sept^r 15th
M_2	"	16.
E_1	Ealing	16...
E_2	"	17.0
Ca_1	Cape	17
D	Dunecht	17
Co_1	Coimbra	18..
S	Sydney	18.
Ca_2	Cape	18..
Co_2	Coimbra	19...
Cor	Cordoba	19...
W	Washington	19

One tenth part of Sun's mean distance.

ELEMENTS OF ORBIT.

T Sept	17·223 G.M.T.
Long. ☊	345° 53′
i	38° 5′ 24″
∏ ☊	69° 35′ 9″
D	0·0080

F.C. Penrose.

the general form of the tail being very similar to the Greek character γ. The southern side still remained the brightest.

Nov. 14, $17^h\ 30^m$.—The nucleus: the two concentrations of light were smaller, more elongated, and much closer together than when last observed. It was only through the definition being exceptionally good that the division could be seen. The whole nucleus was greatly changed, being much narrower and longer than on the 8th inst.

The Orbit of the Great Comet (b) 1882. By F. C. Penrose.

I have obtained by graphical means the elements given below. They are based on

(1) A meridian observation at Washington Sept. 21.
(2) Observations at Rome and Palermo Oct. 1.
(3) Rome, Palermo, Lund, and Athens Oct. 11.

And corrected by Cambridge University Nov. 26.

T	...	...	... Sept. 17·223
Long. of ☊	...	...	345° 53′ 0″
i	...	...	... 38 5 24
$\pi - ☊$	...	...	... 69 35 9
Distance		...	... [7·90309]

The orbit not being distinguishable from a parabola.

The places observed before perihelion do not exactly fit these elements, but would do so if the axis of the parabola be changed about 2° in its own plane. I have not succeeded in finding an orbit with an undeflected axis which would give a good account of the observations taken both before and after perihelion.

The accompanying plate shows the positions observed within about three days of the perihelion as reduced to the node and inclination given above.

It will be seen that the parabola threads its way amongst those taken after perihelion very satisfactorily.

I should add that the graphical work in itself appears to me capable of bringing out an approximation within ten minutes of arc of the finally concluded elements; and that may, I think, be taken as about the limit, unless a very large and inconvenient scale be adopted. The remaining work is done by adjusting the differences numerically.

The observations were corrected for parallax and aberration; and I found that near the perihelion even the graphical work in this orbit was affected very sensibly by these adjustments.

1882, *Jan.* 12.

Note on William Ball's Observations of Saturn.

By Prof. J. C. Adams, M.A., F.R.S.

In No. 9 of vol. i. of the *Philosophical Transactions*, a brief account is given of an observation of *Saturn* made on Oct. 13, 1665, at 6 o'clock, by William Ball, at Mamhead, near Exeter, and it is suggested that the appearance presented by the planet may perhaps be caused by its being surrounded by *two* rings instead of *one*.

This account has recently given rise to considerable discussion; and there are some difficulties connected with it which do not appear to have been satisfactorily cleared up. In a few copies of the volume this account is illustrated by a figure, in which the external boundary of the ring, instead of being of a regular elliptical form, has two blunt notches or indentations at the extremities of the minor axis. The plate containing this figure, however, is wanting in by far the larger number of the copies.

Now, I think, it may be safely asserted that no telescope, capable of showing *Saturn's* ring at all, ever exhibited it in this extraordinary form, and therefore if the above figure faithfully represents William Ball's drawing, he was either a very inaccurate and careless observer, or he must have been provided with very inadequate instrumental means.

On the other hand, we have ample proof that he was a careful and assiduous observer, that in particular he made a long series of observations of *Saturn*, and that these were made with instruments not much inferior to those employed by Huyghens himself in similar observations.

It is well known that Huyghens's discovery of the true nature of the appendage to *Saturn*, which had so puzzled Galileo and others, was contested by Father Fabri at Rome, who wrote under the name of "Eustacius de Divinis."

Huyghens replied to Fabri's objections in a tract which appeared in 1660, entitled *Brevis Assertio Systematis Saturnii sui*, and which is contained in the third volume of his collected works.

In this tract he repeatedly appeals to Ball's observations in England in confirmation of his own. It is clear that Huyghens was in possession of drawings by Ball which represented the various appearances presented by the planet during the four years from 1656 to 1659 inclusive, and that he had carefully compared them with those which he had himself taken during the same interval. After mentioning the dark band which he had observed on the disk of *Saturn* at times when the remainder of the ring was invisible, he quotes a letter from Dr. Wallis, dated Dec. 22, 1658, in which reference is made to an earlier letter dated May 29, 1656, wherein Dr. Wallis had mentioned this band as having been observed by Ball, and had inquired whether his correspondent had likewise perceived it. Huyghens goes on to say that from Feb. 5, 1656, to July 2, when the planet appeared round

and without ansæ, this band or dark shading was observed by Ball to cross the centre of the disk, as shown in his drawing, exactly as in Huyghens's own figure.

Afterwards, when the ansæ had re-appeared, the band was seen with more difficulty, and its position was less accurately laid down in Ball's drawing. From Nov. 5, 1656, to July 9, 1657, when the oblong arms of *Saturn* were seen apparently united to the disk, Ball gives a figure quite similar to that of Huyghens, except that he makes the arms a little thicker.

Again, from Nov. 9, 1657, to June 7, 1658, when the arms were more open, Ball's figure is exactly similar to Huyghens's, except a slight difference in the position of the obscure zone or belt.

Also, finally, the same remark applies to the figure of the planet from Jan. 3, 1659, to June 17 of the same year, when the ansæ were a little more widely opened.

Having made these comparisons between Ball's drawings of the planet and his own, Huyghens remarks that Ball was unacquainted with his hypothesis* (respecting the ring), and therefore could not be supposed to be biased by it, while he himself would not dare to represent the phenomena otherwise than they really were, since, if he did, he might at once be contradicted by the English observer.

This judgment of so competent an authority as Huyghens, made while he had before him all the materials for forming it, left no doubt on my mind as to the merit of Ball's observations.

In order to see whether any further light could be thrown on the subject, I have recently taken an opportunity of consulting the MSS. preserved in the archives of the Royal Society.

Among them I find there is a letter in William Ball's own hand, dated April 14, 1666, in which he makes reference to his observations of *Saturn*, although the greater part of the letter relates to other subjects. He mentions that the observations were made partly with a telescope thirty-eight feet in length, having a double eye-glass, and partly with another telescope twelve feet in length. In the postscript to this letter he gives a small sketch of *Saturn* as it appeared at that time (1666), and he mentions that the same appearance was presented by the planet in 1664. In this figure the external boundary of the ring has the form of a regular oval, without any notches or other irregularities.

No allusion is made to the very different appearance which, if the figure in the *Philosophical Transactions* is authentic, the planet must have presented in 1665.

It should be understood that the paper in the *Philosophical Transactions* which is now in question was not written by Ball himself. It contains, however, a quotation from a letter of Ball to a friend (probably Sir R. Moray), and in what appears to be

* Huyghens's *Systema Saturnium* only appeared in 1659.

the last clause of this quotation, the figure is said to be "a little hollow above and below." I cannot help thinking that this clause has been added or altered in some way to correspond with the given figure. The letter of Ball on which this paper was founded is not in the archives; but there is preserved, not a drawing, but a paper cutting, representing the planet and its ring, which is no doubt the original of the figure engraved in the *Transactions*.

The defect in the paper cutting probably originated in the following way. In order to make the cutting, the paper was first folded twice in directions at right angles to each other, so that only a quadrant of the ellipse had to be cut.

The cut started rightly in a direction perpendicular to the major axis, but through want of care, when the cut reached the minor axis, its direction formed a slightly obtuse angle with that axis instead of being perpendicular to it.

Consequently, when the paper was unfolded, shallow notches or depressions appeared at the extremities of the minor axis.

I imagine that the account in the *Philosophical Transactions* was written by some one inexperienced in astronomical observations, who took for granted that the figure was correct. The mistake being soon discovered, the plate which contained the erroneous figure of *Saturn*, together with two other figures relating to different subjects, was cancelled, and thus its appearance in only a few of the copies is accounted for. The other figures on the cancelled plate were repeated in a new plate which accompanied No. 24 in the same volume of the *Transactions*.

In Lowthorp's abridged edition of the *Transactions* the figure of *Saturn* has been corrected.

I find no evidence that Ball, any more than Huyghens, had noticed any indication of a division in the ring.

It may be interesting to give the original text of the passages of Huyghens's *Brevis Assertio Systematis Saturnii sui*, in which reference is made to Ball's observations.

The citations are taken from the third volume of Huyghens's *Opera Varia*, edited by 'S Gravesande, and published at Leyden in 1724.

"Credo et fasciam nigricantem in *Saturni* disco, liquido sibi conspici dixisset Eustacius, ni Fabrio visum fuisset eam nimium hypothesi meæ annullari favere. Cum autem ne optimis quidem suis perspicillis eam cerni affirmet, hinc quoque quanto illa meis deteriora sint perspicuum sit. Nam ne mihi phenomenon illud confictum credatur, idem et in Anglia pridem observari cœpisse sciendum est; et liquet ex literis viri clar. Joh. Wallisii, Oxonia ad me datis 22 Dec. 1658, quibus inter alia hæc scribit. *Monebam etiam iisdem literis* (nempe *datis* 29 *Maji* 1656) *de Saturni fascia quam jam ante observaverat D. Ball, et sciscitabar num tu eandem conspexeras*, &c. Eam porro fasciam à 5 Feb. 1656 ad 2 Jul., quo tempore rotundus *Saturnus* absque ausis apparuit, medium planetæ discum secare D. Ball adnotavit, ut in schemate ad me misso expressa est. Atque ita mihi quoque

fuerat eo tempore observata, ut cernitur pag. 544 *Systematis Saturnii*, quam figuram hic repeto. Postmodum tamen renatis *Saturni* ansis cum difficillimè conspici eadem fascia cœpisset, minus rectè quoque a D. Ball, quantum ad situm attinet, depicta est. At in mearum observationum adversariis, die 26 Nov. 1656, et alias adscriptum invenio, lineam obscuram fuisse evidentissimam, eo nempe positu, qui pag. 545 *System. Saturnii* memoratur."—Pp. 624, 625.

. . . . . .

"Non ægre nunc fidem habitum iri spero, tum mihi tum Anglis simul observatoribus, qui anno 1657 oblonga *Saturni* brachia disco utrinque conjuncta spectavimus, qualia exhibet figura *Systematis* mei pag. 545, quam hic repono; non autem binorum orbiculorum formâ a medio disco disjunctorum, ut Eustacius se illa eodem tempore vidisse dejerat. Adderem hic schema quod mihi à D. Ball, supra memorato, advenit, nisi planè simile esset huic nostro, hoc uno tantillum duntaxat abludens, quod brachia illa ubique paullo crassiora ille referat.

"Eam vero formam a 5 Nov. 1656 ad 9 Jul. 1657 sibi apparuisse scribit. Apertis autem brachiis, qualis pag. 547 *Systematis* mei et hic representatur, talem à 9 Nov. 1657 ad 7 Jun. 1658, idem observator depingit, simillima prorsus figura, nisi quod ad positum zonæ obscuræ attinet, de quo dixi suprà. Ac denique à 3 Jan. 1659 ad 17 Jun. ejusdem anni, ansis paulo latius adhuc apertis. Et hæc quidem ille, ignarus adhuc meæ hypotheseos, ne ob præconceptam opinionem aliquid indulsisse sibi existimetur. Neque ego aliter quam se revera habent referre auderem, cum redarguere me, si fallam, autori observationum in promptu sit."—P. 626.

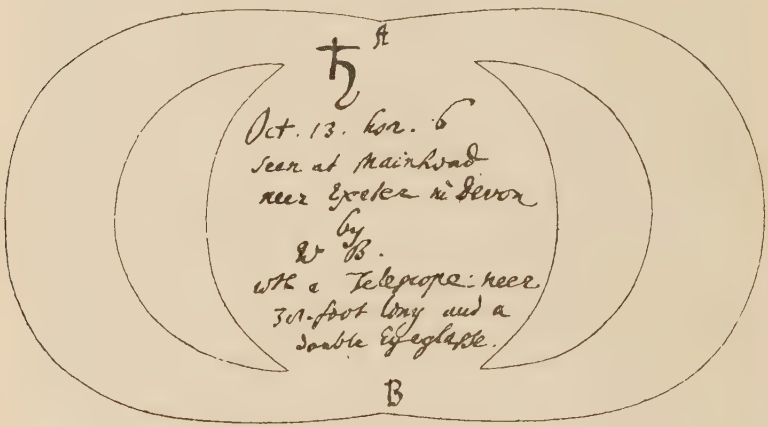
The following extract comprises all that is material in the Paper in the Philosophical *Transactions*:—

"This observation was made by Mr. William Ball, accompanied by his brother, Dr. Ball, October 13, 1665 at six of the Clock, at Mainhead near Exeter in Devonshire, with a very good Telescope near 38 foot long, and a double Eye-glass as the observer himself takes notice, adding, that he never saw that planet more distinct. The observation is represented by Fig. 3 concerning which, the Author saith in his letter to a friend, as follows, This appear'd to me the present figure of Saturn, somewhat otherwise, than I expected, thinking it would have been decreasing, but I found it full as ever, and a little hollow above and below. Whereupon the Person, to whom notice was sent hereof, examining this shape, hath by letters desired the worthy Author of the *System of this Planet*, that he would now attentively consider the present Figure of his Anses, or Ring, to see whether the appearance be to him, as in this Figure, and consequently whether he there meets with nothing that may make him think, that it is not *one* body of a circular Figure, that embraces his Disk, but *two*."

From this it is clear that the suggestion of *two* rings was made, not by Ball himself, but by his anonymous correspondent.

By the kind permission of the President and Council of the Royal Society, I am enabled to make the following extracts from two letters in William Ball's own hand, and likewise to give exact representations of the form of the paper-cutting, and of Ball's small sketch of *Saturn*, referred to in the foregoing Paper, both of which have been kindly copied for me by our Assistant-Secretary, Mr. Wesley.

The annexed figure shows the form of the paper-cutting.



The writing on the cutting appears to be in Oldenburg's hand.

The first letter is dated Mamhead, April 14, 1666, and is probably addressed to Oldenburg.

"I have seen ♄ two mornings this year (with a 12 foot glasse the longest I can use at this time with convenience) and find the figure the same as it was in –64. What his figure was last autumne (by mee observed with 38 foot glasse much better than that at Gresham Colledge) I suppose Sr. R. Moray hath communicated. I could not have a second sight, straining very much for that one, for the shadow of the body on his ring I doe not well understand the meaning but I suppose I saw the same thing; for I never had a clearer sight of him in any glasse I ever looked in, one thing I can boast of, sc. I am not prejudiced with any conceit of hypothesis which doth commonly send all observations to favour one side and soe there must bee a little added or diminished as the designe requires," &c. &c.

In a postscript is the following, with the little sketch:—

"I saw ♄ this morn. at 4 a clock with 12 foot glasse and judge him the same figure as in –64—that is just ovall with two black spotts and I thinke a faint shadow of a belt which I have alwaies seene, but will not be peremptory in itt."

The second letter is dated "Mamhead ♄ September 15,-66," and is addressed "For Sir Robert Moray K^t at Whitehall, These."

"I designe to send you all the figures of ♄. I promised them my L^d Brounker and hee was pleased most kindly to accept itt but I (like any thing you please to call mee bad enough) have hitherto shamfully failed, as alsoe of an account of husbandry to Mr. Oldenburg. I am still gazing at the starrs though to very little purpose more then to keep my eyes in use,"&c. &c.

It will be noticed that the passage in Ball's first letter in which he claims to be unbiased by any hypothesis, agrees with the statement of Huyghens respecting him.

The passage in the same letter, "for the shadow of the body on his ring I doe not well understand the meaning but I suppose I saw the same thing," I conjecture to refer to an attempted explanation by Huyghens, or some other astronomer, of the phenomenon observed by Ball, by attributing it to the shadow of the body of the planet cast on his ring.

It is plain that such an explanation would not be applicable, if similar depressions had been observed at the two extremities of the minor axis of the ring.

Observations of Jupiter. By W. F. Denning.

The southern equatorial belt of *Jupiter* is by far the most conspicuous feature at present visible on the surface of the planet. This belt is double, and can be readily traced as two perfectly parallel bands in all parts of the circumference except in the region immediately N. of the great red spot where it is connected at the *p.* and *f.* ends of the spot. At these points the southernmost half of the belt slopes abruptly to the N., and runs into the northernmost half, so that the great red spot now apparently lies south of a great cavity in the configuration of the dusky equatorial belts.

In the immediate region of the planet's equator, numerous dark spots and irregular patches appear from time to time, and it is important that the rotation period of these objects should be determined. They usually lie on the equatorial border of the great S. belt, and in approximately the same latitude as the permanent white spots to which so much attention has lately been given. On Oct. 26, 1882, just before daylight, I noticed a very conspicuous marking of this character slightly preceding the white equatorial spot. I re-observed this peculiar dark spot on many subsequent occasions, and recorded its times of transit across the central meridian of *Jupiter* relatively to the well-known white spot. The results show that the two objects have a common rotation period, whence we may assume that all the various markings both light and dark along the equator

participate in a swift movement past the red spot. The following were the estimated times of transit recorded between Nov. 1 and Nov. 26, after which cloudy weather and other circumstances prevented a continuation of the observations :—

1882.	Equatorial Dark Spot central.	Equatorial White Spot central.	Dark Spot precedes White Spot.
	h m	h m	m
Nov. 1	17 22	17 40	18
3	18 33	18 50	17
4	14 7	14 25	18
5	9 48	10 1	13
8	16 33	16 48	15
9	12 13	12 28	15
10	17 48	18 3	15
26	7 30	7 45	15
26	17 24	17 37	13

The interval separating the spots decreased from 18^m to 13^m during the 25 days, but considering the approximate nature of the observations and the fact that the estimated intervals were identical on Nov. 5 and 26, it is certain that the difference (if any) in the rotation periods of the two objects must have been so small as to escape certain detection. It therefore appears that the frequent obscuration of the white equatorial spots are not originated by a swifter motion of the dark spots in the same latitude, for both objects are seemingly influenced by the same current. This accords with Prof. Hough's observations in 1881 ; he found that the drift of the dark matter in the equatorial regions was essentially the same as that of the white spots. While, however, a uniform velocity appears to influence these markings on the equatorial half of the great Southern belt, causing them to become displaced, relatively to the position of the red spot, to the extent of 8° of longitude daily, it is certain that the southernmost half of the belt remains stationary with reference to the red spot, for during the three oppositions of 1880, '81, and '82 the junction of the belt N. of the *f* end of the red spot has retained a fixed position.

In the region N. of the planet's equator many changes have occurred during the last few months. A considerable number of dusky patches have made their appearance, and a few brilliant white spots are visible where, in 1880, the planet's dark N. belt was very conspicuous. In November I observed the return of a brilliant spot N. of the equator, and found that it moved perceptibly slower than the somewhat similar and evidently more permanent spot slightly S. of the equator. The following were the times :—

1882.	N. equatorial White Spot central. h m	S. equatorial White Spot central. h m	m
Oct. 30	15 56	16 22	N. spot precedes S. 26
Nov. 1	17 22	17 40	„ „ 18
3	18 41	18 50	„ „ 9
4	14 23	14 25	„ „ 2
5	10 4	10 1	„ follows S. 3
8	17 1	16 48	„ „ 13
9	12 39	12 28	„ „ 11
10	18 22	18 3	„ „ 19
11	14 5	13 43	„ „ 22
19	9 25	8 37	„ „ 48
26	18 48	17 37	„ „ 71

The spot N. of the equator lost 97 minutes in 27 days, so that (the period of the S. spot being $9^h\ 50^m\ 7^s$) its rotation was performed in about $9^h\ 51^m\ 40^s$, or 4 minutes less than the red spot and $1\frac{1}{2}$ minutes greater than that of the white spot S. of the equator. On Nov. 26 the N. spot had become extremely faint and could not be followed any longer, yet early in November it was far brighter than the S. spot, and formed a very conspicuous feature upon the planet.

It is evident from these and many other recent observations of markings included within the equatorial belts, and of those situated further towards the poles, that the rotation periods vary in a very irregular and unaccountable manner. They do not seem to be affected or controlled by any law depending upon their latitudinal distribution. It appears certain, however, that the markings on and skirting the planet's equator *generally* move with far greater velocity than those outside the equatorial belts. This conclusion is warranted by the independent results of several observers, but it is nevertheless liable to great exceptions. In the autumn and winter of 1880 an eruption of dark spots occurred on a belt approximately situated 25° N. of the planet's equator. These spots were first seen by Mr. F. C. Dennett at Southampton, on Oct. 17, and afterwards very generally observed, when it was found that they not only increased in numbers and size, but showed a rapid motion relatively to the red spot. Their rotation period was about $9^h\ 48^m$, and they completed a revolution of *Jupiter* relatively to the red spot in about 32 days. These markings moved with greater velocity than any others, the periods of which have ever been determined, and the fact is very important as they were so far removed from the equator.

Prof. Hough, in his valuable summary of observations at Chicago, says: "The observations of the small white spots during 1880 and 1881 prove that the whole surface of the planet outside the margin of the equatorial belt rotates with nearly the

same rate;" and, "From observations on the small white spots, as well as on dark markings near the equator, it is probable that the matter in the equatorial regions constantly drifts in the direction of the planet's rotation; and it seems probable that the rate of this drift depends on the latitude." The dark spots seen in 1880 far N. of the equator, by many English observers, apparently furnish a negative to this conclusion. It is possible, however, that the small white spots outside the equatorial zone move slower than the dark markings referred to. It is evident that the different velocities of the various spots offer a very complex problem for solution. It may be that though these velocities follow no law dependent upon distance from the equator, they may each be special to the zones in which they occur. Or they may possibly be accounted for on the thesis that the planet is enveloped in a series of dense atmospheric layers or shells, each of which, according to height, manifests a different rate of motion, which becomes revealed either by temporary disruption or partial decadence of the outer envelopes. There is, probably also vast differences of temperature in the various markings observed, and this may originate another element of disturbance. In any case, we may be assured that all the varieties of spots and streaks observed so persistently and numerously upon the planet are the phenomena of his dense atmosphere and not objects of stability upon his actual surface, which seems to be entirely shrouded from our scrutiny by masses of heated vapour which are woven into parallel bands by the effects of a very rapid rotatory movement. The further telescopic study of these remarkable markings cannot fail to prove of considerable interest, and may perhaps lead to the partial elucidation of what now appears to present difficulties beyond explanation.

Bristol: 1883, *Jan.* 11.

Postscript, on a Communication made to the Royal Astronomical Society, in November last, on Stellar Photometry. By Professor C. Pritchard, D.D., F.R.S.

Since my last communication in November 1882, I have had an opportunity of examining another wedge of neutral-tinted glass constructed for Mr. Knott by Mr. Hilger. It has been scrupulously measured by the same photometrical process as that described in my paper already referred to. The instrument I find to be practically uniform in its action throughout its extent of 6 inches in length, but I have also furnished Mr. Knott with a table, theoretically exact, by means of which, from simple inspection, he may be able to reduce the graduated indications of the wedge to the difference of the magnitudes of any star whose light is just extinguished by the instrument. I need scarcely repeat that, although on different nights, the same star will be

extinguished at very perceptibly different parts of the wedge, the intervals of length between the points of extinction of the lights of two stars will be found to be sensibly the same on different nights. After the application of this photometer to many thousand measures, I can hardly conceive any photometrical process more simple either in the way of observation or in the subsequent reduction of the observations.

If this were all that I have to say on the subject, I should not be justified in at present occupying the valuable time of the Society's meeting. But in measuring photometrically Mr. Knott's wedge, I took the opportunity of still further testing its capacity, in respect of its capability of measuring the relative intensity of light of *different colours*.

I had already established the fact that the same thickness of wedge reduces the ratio of the incident and emergent lights in the same degree, whatever may be the colour of the light. But it seemed to me to be desirable to inquire further, whether two equal lights of two different colours would be extinguished at the same point of the wedge. This experiment seemed crucial as to the applicability of the photometer to stars of different colours, and especially of double stars of this description. Accordingly, I arranged an apparatus, consisting of a rhomb of calcspar, a uniform plate of selenite, and a Nicol prism, and in this way I obtained two coloured images of a small rectangular aperture illuminated with white light from the sky, the apparatus being so arranged that the two coloured images must possess theoretically the same intensity. The two coloured lights—in this instance, yellow and its complementary green—were extinguished at practically the same point of the wedge. This experiment, which was verified by no less than four experienced observers, appears to establish the applicability of the instrument to stellar photometry irrespective of the colours of individual stars. In this inquiry I was greatly assisted by the experience and personal aid of H. B. Dixon, Esq., of Trinity College, whose photometrical researches while Secretary to a Royal Commission on the subject of standard candles and the quality of illumination by coal gas, are well known.

Notwithstanding the theoretical equality of the two complementary coloured lights, to the unaided eye of all the observers the yellow light appeared to be the brighter of the two lights: probably the yellow light would have been estimated at half a magnitude brighter than the green; and this fact, I think, explains the circumstance that Prof. Pickering's measures of the relative magnitude of the two components of *β Cygni* assign a greater degree of brightness to the larger yellow component compared with that of the smaller and blue component than is assigned to it in the Oxford photometry. The measures of relative brilliancy of the two components give the following results (*Monthly Notices*, vol. xliii. p. 5):—

Harvard College, diff. of magnitude		2·14
Oxford	,,	1·74
Oxford repeated (Nov. 6)	,,	1·82

Having reason to place great reliance on Professor Pickering's photometry, I directed the re-observation of the stars. The result (given above) confirmed the Oxford measure, and nothing remained for me but to agree to differ from the Harvard result. I think the trifling discrepancy, for after all it is but trifling, admits now of a very satisfactory explanation. The Harvard photometer is on the principle of applying the judgment of the eye to the equality of light; the Oxford method relies on the judgment of the eye as to the point of extinction of a light. Each is valuable in its way, but as at present advised (and with special reference to the experiment just mentioned) I am inclined to place a greater reliance on the latter method in the case of photometry of double stars of *different* colours.

I will close this note by stating that the photometry of the brighter stars from the Pole to the Equator is now completed, and that before the reading of this note to the Society I shall be on my way to Cairo for the purpose of instituting some inquiries respecting the atmospheric and climatic effects on the absolute brilliancy of stars, which appear to me to be essential to the completion of this photometric research.

Reduction of Latitude and Logarithm of the Earth's Radius with Col. Clarke's Value of the Earth's Compression. By E. J. Stone, M.A., F.R.S.

The semi-diameters of the spheroid, which best represents the Earth's surface, determined by Col. Clarke, differ considerably from those found by Airy and Bessel.

The following are the results for the Equatorial and Polar semi-diameters expressed in English feet:—

		a	b	$a : b$
Airy	...	20923713	20853810	299·33 : 298·33
Bessel	...	20923600	20853656	299·15 : 298·15
Clarke	...	20926202	20854895	293·465 : 292·465

The two first results agree in a very remarkable manner; but to a great extent they were deduced from a discussion of the same data.

A large mass of observations, bearing on the question of the figure of the Earth, have recently been made available, and Col. Clarke has attacked the question with far more extensive materials than were available to Airy or Bessel in their discussions. I presume therefore we must accept Col. Clarke's

results as more accurate than those of Airy and Bessel, and that Col. Clarke's value of the ratio $a : b$ ought to be adopted for use in our calculations.

I have therefore formed a table, with Col. Clarke's value of the ratio $a : b$, of the *reductions* from the astronomical or geographical latitudes to the geocentric latitude, and also the *logarithms* of the ratios of the radii to the equatorial semi-diameter.

The formulæ from which the computations have been made are as follows:—

$$e^2 = 1 - \frac{b^2}{a^2} \qquad \epsilon = \frac{e^2}{2} + \left(\frac{e^2}{2}\right)^2 + \left(\frac{e^2}{2}\right)^3. \qquad \text{M} = \text{mantissa of base 10.}$$

ϕ, ϕ' the astronomical and geocentric latitudes.

$$\phi' = \phi - \frac{\epsilon \cdot \sin 2\phi}{\sin 1''} + \frac{\epsilon^2}{2} \cdot \frac{\sin 4\phi}{\sin 1''} - \frac{\epsilon^3}{3} \cdot \frac{\sin 6\phi}{\sin 1'''},$$

$$\log \frac{r}{a} = \text{M} \left\{ \left(-\frac{e^2}{4} - \frac{e^4}{32} + \frac{e^6}{96} \right) + \cos 2\phi \left(+\frac{e^2}{4} + \frac{e^4}{8} + \frac{3}{64} e^6 \right) + \cos 4\phi \left(-\frac{3}{32} e^4 - \frac{3}{32} e^6 \right) + \cos 6 \left(\frac{7}{2} e^6 \right) \right\}$$

The terms sin 6ϕ and cos 6ϕ are insensible to the order of approximation adopted.

ϕ	$\phi - \phi'$	Diff.	log. ρ	Diff.
° ′	′ ″	″		
0 0	0 0·00	24·49	0·0000000	3
1 0	0 24·49	24·46	9·9999997	14
2 0	0 48·95	24·39	9983	22
3 0	1 13·34	24·31	9961	31
4 0	1 37·65	24·20	9930	40
5 0	2 1·85	24·04	9890	49
6 0	2 25·89	23·87	9·9999841	58
7 0	2 49·76	23·67	9783	66
8 0	3 13·43	23·43	9717	75
9 0	3 36·86	23·17	9642	83
10 0	4 0·03	22·88	9559	92
11 0	4 22·91	22·56	9467	100
12 0	4 45·47	22·22	9·9999367	109
13 0	5 7·69	21·85	9258	116
14 0	5 29·54	21·45	9142	124
15 0	5 50·99	21·02	9018	133
16 0	6 12·01	20·58	8885	139
17 0	6 32·59	20·10	8746	147

ϕ	$\phi-\phi'$	Diff.	log. ρ	Diff.
18° 0′	6′ 52″·69	19·60	9·9998599	155
19 0	7 12·29	19·08	8444	161
20 0	7 31·37	18·54	8283	169
21 0	7 49·91	17·97	8114	175
22 0	8 7·88	17·37	7939	182
23 0	8 25·25	16·77	7757	187
24 0	8 42·02	16·13	9·9997570	194
25 0	8 58·15	15·49	7376	200
26 0	9 13·64	14·81	7176	206
27 0	9 28·45	14·12	6970	210
28 0	9 42·57	13·42	6760	216
29 0	9 55·99	12·70	6544	221
30 0	10 8·69	2·04	9·9996323	37
10	10·73	2 03	6286	37
20	12·76	2·00	6249	38
30	14·76	1·98	6211	37
40	16·74	1·97	6174	38
50	18·71	1·94	6136	38
31 0	10 20·65	1·92	9·9996098	38
10	22·57	1·90	6060	38
20	24·47	1·88	6022	38
30	26·35	1·85	5984	38
40	28·20	1 84	5946	39
50	30·04	1·81	5907	38
32 0	10 31·85	1·80	9·9995869	39
10	33 65	1 77	5830	39
20	35·42	1·75	5791	39
30	37·17	1·73	5752	38
40	38·90	1·71	5714	39
50	40·61	1·68	5675	
33 0	10 42·29	1·67	9·9995635	39
10	43 96	1·64	5596	39
20	45 60	1·62	5557	40
30	47·22	1·60	5517	39
40	48·82	1·58	5478	40
50	50·40	1·55	5438	40

ϕ	$\phi-\phi'$	Diff.	log. ρ	Diff.
° ′	′ ″	″		
34 0	10 51·95	1·54	9·9995398	40
10	53·49	1·51	5358	40
20	55·00	1·49	5318	40
30	56·49	1·46	5278	40
40	57·95	1·45	5238	40
50	59·40	1·42	5198	41
35 0	11 0·82	1·40	9·9995157	40
10	2·22	1·38	5117	41
20	3·60	1·36	5076	40
30	4·96	1·33	5036	41
40	6·29	1·31	4995	41
50	7 60	1·29	4954	40
36 0	11 8·89	1·27	9·9994914	41
10	10·16	1·24	4873	41
20	11·40	1·22	4832	41
30	12 62	1·20	4791	41
40	13·82	1·17	4750	42
50	14 99	1·15	4708	41
37 0	11 16·14	1·13	9·9994667	41
10	17·27	1·11	4626	42
20	18·38	1·08	4584	41
30	19·46	1·06	4543	42
40	20·52	1·04	4501	42
50	21·56	1·02	4459	41
38 0	11 22·58	0·99	9·9994418	42
10	23·57	·97	4376	42
20	24 54	·94	4334	42
30	25·48	·93	4292	42
40	26·41	·90	4250	42
50	27·31	·87	4208	42
39 0	11 28·18	0·85	9·9994166	42
10	29·03	·83	4124	42
20	29·86	·81	4082	42
30	30·67	·78	4040	43
40	31·45	·76	3997	42
50	32·21	·74	3955	42

ϕ	$\phi-\phi'$	Diff.	log. ρ	Diff.
40° 0′	11′ 32″·95	″ 0·71	9·9993913	43
10	33·66	·69	3870	42
20	34·35	·67	3828	43
30	35·02	·64	3785	42
40	35·66	·62	3743	43
50	36·28	·59	3700	42
41 0	11 36·87	0·57	9·9993658	43
10	37·44	·55	3615	43
20	37·99	·53	3527	42
30	38·52	·50	3530	43
40	39·02	·47	3487	43
50	39·49	·46	3444	43
42 0	11 39·95	0·43	9·9993401	43
10	40·38	·40	3358	43
20	40·78	·39	3315	42
30	41·17	·36	3273	43
40	41·53	·33	3230	43
50	41·86	·31	3187	43
43 0	11 42·17	0·29	9·9993144	43
10	42·46	·26	3101	43
20	42·72	·24	3058	43
30	42·96	·22	3015	43
40	43·18	·19	2972	43
50	43·37	·17	2929	44
44 0	11 43 54	0·15	9·9992885	43
10	43·69	·12	2842	43
20	43·81	·10	2799	43
30	43·91	·07	2756	43
40	43·98	·05	2713	43
50	44·03	·02	2670	43
45 0	11 44·05	0·01	9·9992627	43
10	44·06	·03	2584	43
20	44·03	·04	2541	44
30	43·99	·07	2497	43
40	43·92	·09	2454	43
50	43·83	·12	2411	43

ϕ	$\phi - \phi'$	Diff.	log. ρ	Diff.
° ′	′ ″	″		
46 0	11 43·71	0·14	9·9992368	43
10	43·57	·17	2325	43
20	43 40	·18	2282	43
30	43·22	·22	2239	43
40	43·00	·23	2196	43
50	42·77	·26	2153	43
47 0	11 42·51	0·29	9·9992110	43
10	42·22	·30	2067	43
20	41·92	·34	2024	43
30	41·58	·35	1981	43
40	41·23	·38	1938	43
50	40·85	·40	1895	43
48 0	11 40·45	0·43	9·9991852	43
10	40·02	·45	1809	43
20	39·57	·47	1766	43
30	39·10	·50	1723	43
40	38·60	·52	1680	43
50	38·08	·55	1637	43
49 0	11 37·53	0·56	9·9991594	42
10	36·97	·60	1552	43
20	36·37	·61	1509	43
30	35·76	·64	1466	42
40	35·12	·66	1424	43
50	34·46	·69	1381	42
50 0	11 33·77	0·71	9·9991339	43
10	33 06	·73	1296	42
20	32·33	·76	1254	43
30	31·57	·78	1211	42
40	30·79	·80	1169	43
50	29·99	·83	1126	42
51 0	11 29·16	0·85	9·9991084	42
10	28·31	·88	1042	42
20	27·43	·89	1000	42
30	26·54	·92	0958	42
40	25·62	·95	0916	42
50	24·67	·96	0874	42

ϕ	$\phi-\phi'$	Diff.	log. ρ	Diff.
° ′	′ ″	″		
52 0	11 23·71	1·00	9·9990832	42
10	22·71	1·01	0790	42
20	21·70	1·03	0748	42
30	20·67	1·06	0706	42
40	19·61	1·09	0664	41
50	18·52	1·10	0623	42
53 0	11 17·42	1·13	9·9990581	42
10	16·29	1·15	0539	41
20	15·14	1·18	0498	42
30	13·96	1·20	0456	41
40	12·76	1·21	0415	41
50	11·55	1·25	0374	41
54 0	11 10·30	1·26	9·9990333	41
10	9·04	1·29	0292	41
20	7·75	1·31	0251	41
30	6·44	1·34	0210	41
40	5·10	1·35	0169	41
50	3·75	1·38	0128	41
55 0	11 2·37	1·40	9·9990087	40
10	11 0·97	1·43	0047	41
20	10 59·54	1·44	0006	40
30	58·10	1 47	9·9989966	41
40	56·63	1·49	9925	40
50	55·14	1·52	9885	40
56 0	10 53·62	1·53	9 9989845	40
10	52·09	1·56	9805	40
20	50·53	1·58	9765	40
30	48·95	1·60	9725	40
40	47·35	1·63	9685	40
50	45·72	1·64	9645	39
57 0	10 44·08	1·67	9·9989606	40
10	42·41	1 69	9566	39
20	40·72	1·71	9527	39
30	39·01	1·73	9488	40
40	37·28	1·76	9448	39
50	35·52	1·77	9409	39

ϕ	$\phi-\phi'$	Diff.	log. ρ	Diff.
58° 0′	10′ 33″·75	1·80	9·9989370	
10	31·95	1·82	9331	39
20	30 13	1·84	9293	38
30	28·29	1·86	9254	39
40	26·43	1·89	9216	38
50	24·54	1 90	9177	39
59 0	10 22·64	1·93	9·9989139	38
10	20·71	1·95	9101	38
20	18·76	1·96	9063	38
30	16 80	1·99	9025	38
40	14·81	2 01	8987	38
50	12·80	2·03	8949	38
60 0	10 10·77	12·62	9·9988911	223
61 0	9 58 15	13·35	8688	218
62 0	9 44·80	14·06	8470	213
63 0	9 30·74	14·77	8257	208
64 0	9 15·97	15·45	8049	202
65 0	9 0·52	16·11	7847	197
66 0	8 44·41	16·76	9·9987650	190
67 0	8 27·65	17·37	7460	184
68 0	8 10·28	17 98	7276	178
69 0	7 52·30	18·56	7098	171
70 0	7 33·74	19·11	6927	164
71 0	7 14·63	19·65	6763	157
72 0	6 54 98	20·16	9·9986606	150
73 0	6 34·82	20·65	6456	142
74 0	6 14·17	21·10	6314	134
75 0	5 53·07	21·54	6180	127
76 0	5 31·53	21·95	6053	119
77 0	5 9·58	22·32	5934	110
78 0	4 47·26	22·68	9·9985824	102
79 0	4 24·58	23·01	5722	93
80 0	4 1·57	23·30	5629	86
81 0	3 38·27	23·57	5543	76
82 0	3 14·70	23·81	5467	68
83 0	2 50·89	24·02	5399	58

ϕ	$\phi - \phi'$	Diff.	log. ρ	Diff.
84° 0′	2′ 26″·87	24″·20	9·9985341	50
85 0	2 2·67	24·35	5291	41
86 0	1 38·32	24·48	5250	32
87 0	1 13·84	24·56	5218	23
88 0	0 49·28	24·62	5195	13
89 0	0 24·66	24·66	5182	5
90 0	0 0·00		5177	

Meteors and Meteorology. By Richard A Proctor.

It will be in the knowledge of most of the Fellows of this Society that Erman long since maintained a meteoric theory in explanation of the so-called "cold days" which occur in February, April, and May. He believed that the cold which on the average of a great number of years is found to characterise those days is due to the existence of meteoric streams between the Earth and the Sun. He even held that the cold of February is due to the August meteor system, whose ascending node would have about the same heliocentric longitude as the Earth has at the middle of the February cold spell; while in like manner he associated the cold days of May with the November meteors. We now know that this part of his theory is mistaken. The ascending nodes of those two important meteor systems lie in the right heliocentric longitude; but, unfortunately for the theory, both meteor systems cross the plane of the ecliptic ascendingly far outside the Earth's orbit, so that she may throw her shadow on the meteors of those systems, but cannot possibly be shadowed by them.

I have been in the habit of regarding Erman's theory as probably erroneous altogether, though noting that it would have to be accepted if any evidence were obtained showing the whole Earth, and not Europe only, to undergo these periodical refrigerations. Mr. Russell, Government Observer at Sydney, has recently published evidence which seems to go a great way towards proving that this really is the case. In Australia and in America, it would seem, the average temperature of the cold days is lower than it should be if the seasonal rise from January to July were steadily maintained. He also quotes evidence obtained in Galileo's time, which shows that the same peculiarity was recognised in Europe more than two centuries and a half ago. That sometimes the fall of temperature must have been very marked is shown by the existence of popular proverbial expressions, doggerel verses, and so forth, in reference to these cold spells.

It seems to me, then, that we must revert to the meteoric theory, recognising in the existence of meteoric systems between

the Earth and Sun the explanation of the average fall of temperature,* while in the incompleteness of meteoric rings we find explanation of the frequent absence of all fall of temperature at these times ; and in the great wealth of that part of such systems which has been poetically called the gem of the meteor ring we find an explanation of the intense cold often felt on the ill-omened days, such cold as to justify what has been said of the three April "cold days"—

> The first of them is wan and weet,
> The second it is cold and sleet,
> The third it comes with sic a freeze
> As gars the birds stick to the trees.

It would be of interest, I believe, to many if at those places where underground temperature is noted the average and also the actual temperatures for the cold days could be noted during many successive years. If meteoric shadow is in question, it is probable that the meteor systems, or at least those parts which cast the shadow, are near the Sun. If so, there might be some slight but discernible change in the solar spectrum on those days. If (as I trust) Dr. Huggins has really succeeded in securing photographs of the solar corona with the Sun uneclipsed, and if (as I believe) the outer coronal radiations are meteoric, we may be able before long to obtain more definite information on this question. It may even perhaps be shown that more extended meteorological relations depend on meteoric systems near the Sun, and that Sun-spots may be relieved of part of the imputations cast on them as weather-breeders. We might even find in meteoric periodicity near the Sun the explanation of Sun-spots themselves.

The Aquariads of April 29 to May 3 (Tupman, No. 33).

By W. F. Denning.

On April 30 and May 2–3, 1870, and again on April 29, 1871,† Col. Tupman observed a remarkably fine shower of meteors from points averaging $326° - 2\frac{1}{2}°$ near *a Aquarii*. The meteors were very brilliant, with streaks and long paths. This shower, being only visible for a short interval before sunrise, has received no good confirmation from subsequent observations. But it now appears that the recently published *Osservazioni di Stelle Cadenti fatte nelle stazioni Italiane durante gli anni* 1868, 1869 *e* 1870, in which are recorded the paths of 7602 shooting stars (chiefly

* It may be observed that in our almanacs no notice is taken of the peculiarity. It is treated as merely accidental, and the average temperatures are corrected (?) so as to rise and fall uniformly throughout the year. Buchan gives in his *Handy-book of Meteorology* a meteorological explanation which might hold but for Mr. Russell's evidence.

† There is some doubt as to the year in this case. In the B. A. Catalogue of Col. Tupman's observations it is given as 1871, but in the *Monthly Notices*, vol. xxxiii. p. 301, it is stated as 1869.

observed in 1870), that many of the meteors of Col. Tupman's shower were seen by the Italians, though the fact has previously escaped comment, as the observations have never been reduced. I have projected the apparent paths of 229 meteors in this catalogue recorded during the period from April 29 to May 6, 1870, between the hours of 13 and $15\frac{1}{2}$, and find that at least 45 of these appear most unquestionably to have belonged to this shower of Aquariads, and the confirmation is important as being based on observations made simultaneously with those of Col. Tupman.

The radiant point of this stream, as I have derived it from this new source, is at $335°-9°$, which is some 11° S.E. of the place determined by Col. Tupman. I projected the apparent paths both upon the star charts prepared by the B. A. Committee on Luminous Meteors and upon a celestial globe of 18 in. diameter. I adopted the latter plan as a means of finding the length of path traversed in each case. The average of 45 meteors (24 of which were seen on the morning of May 4, 1870) is $34°{\cdot}7$, which is much greater than the ordinary length of meteor tracks. Their brightness also appears to have been very exceptional, 1 being estimated= ♀, 2=♃, and 13=first mag. stars. The mean length of 11 Aquariads registered by Col. Tupman on the morning of May 3, 1870, was $20°{\cdot}5$, which also far exceeds the average; and Mr. Corder, at Writtle, describes three of the meteors of this shower observed by him on the morning of May 4, 1878, as "remarkable for great length of path." These Aquariads are usually represented as swift, with bright streaks; and the inordinately long flights thus attributed to them by several different observers sufficiently prove them to have been directed from a radiant point very low on the horizon.

Giuseppe Zezioli, at Bergamo, recorded three Aquariads on the morning of May 3, 1868; and Mr. Corder has fixed the position of the radiant at $334°-5°$ from six "fine long meteors," which he himself observed* before daybreak at the end of April and beginning of May. My own efforts to observe this shower have generally been frustrated either by clouded skies or moonlight. In 1880 it must, however, have become extremely feeble, for watching the eastern sky between $14^h\ 15^m$ and 15^h on May 2 I only saw two shooting stars, of which one was clearly an Aquariad.† It rose upwards in the W. region of *Pegasus*, and was therefore not far from the radiant point which from this single observation I judged to lie slightly to the E. of the position assigned by Mr. Corder.

It seems obvious from the reduction of the meteors seen in Italy in 1870 and from Mr. Corder's later observations that the radiant point of this brilliant shower is really situated to the S.E. of the place originally given by Col. Tupman. This may be easily settled by future observations if the display continues

* *Monthly Notices*, vol. xl. p. 135, radiant No. 23.
† *Observatory*, vol. iii. p. 449.

actively visible. Certainly on the morning on May 3, 1880, it was very feeble, and may now quite possibly have died out altogether. It should, however, be looked for with close attention during the next few years. The shower is a very important one, inasmuch as it agrees with the radiant point computed for Halley's Comet (1835, III.), whose nearest approach to the Earth's orbit occurs twelve days before reaching the descending node. Prof. Herschel gives the cometary radiant as $337° \pm 0°$ May 4,* and this falls significantly close to the meteoric radiant. The agreement, though striking, may of course be purely accidental, but there is no doubt this shower of meteors should be assiduously looked for with a view to determine the exact centre of divergence, and whether its activity has been sustained since the very rich display of 1870.

The following are the observed paths of 45 meteors registered by the Italians in 1870, and presumably belonging to this shower of Aquariads :—

Date and Hour. 1870.	Mag.	Observed Path From α δ	To α δ	Length of Path.	Appearance.	Observer.
April 29.						
h m						
13 27	1	337+54	151+53	85	V. slow; streak	V.
14 32	2	195+74	164+41	36	Swift; streak	V.
13 36	2	351+61	120+69	45	„	Gi.
April 30.						
15 20	3	182+58	163+41	21	V. swift	M.
15 20	4	182+58	165+46	16	„	M.
May 3.						
14 25	2	170+83	163+61	22	Swift; streak	V.
14 40	3	20+64	68+73	19	Swift	V.
15 55	3	250+64	203+54	25	Slow	V.
14 52	3	319+11	312+37	27	Swift; streak	Bz.
14 53	2	157+81	158+62	19	„	Ga.
14 55	3	327+17	317+41	25	Swift	Bz.
15 8	3	160+90	160+69	21	V. swift	Ba.
15 28	3	190+80	166+60	21	Swift	C.
14 15	1	3+39	28+50	21	Swift; streak	I.
14 26	1	268+40	202+48	47	„	I.
14 26	4	202+56	178+47	18	Swift	I.
14 41	2	357+30	13+43	18	Swift; streak	I.
15 5	4	180+78	146+50	31	„	I.
15 36	3	349+60	29+73	20	Slow	I.

* B. A. Report on Luminous Meteors for 1875, pp. 229, 232. *Monthly Notices*, vol. xxxvi. p. 222, and vol. xxxviii. p. 379.

Date and Hour. 1870.	Mag.	Observed Path From α δ	To α δ	Length of Path.	Appearance.	Observer.
May 3.						
h m						
13 40	♀	359+31	121+58	88	V. slow	Z.
13 55	1	357+37	7+47	12	Swift	Z.
13 57	1	294+11	265+32	34	V. swift	Z.
14 43	1	322+8	313+17	12	Swift	Z.
13 8	3	8+56	26+63	11	V. swift	M.
13 46	1	339+29	40+55	50	V. slow; streak	M.
14 1	3	28+82	147+42	53	Slow; streak	M.
14 45	1	353+42	34+67	33	,,	M.
14 53	1	308+15	278+39	35	,,	M.
15 3	1	140+71	142+52	19	,,	M.
May 4.						
14 34	2	286+42	205+50	55	Swift; streak	Be.
14 47	5	316+29	306+42	16	V. swift	Be.
May 5.						
14 20	3	16+63	120+66	40	Slow	S.
14 21	3	12+60	110+70	38	Swift; streak	D.
14 22	5	50+72	111+69	21	V. swift	G.
14 35	1	336+29	26+63	46	V. swift; streak	G.
14 56	2–3	330+60	155+69	52	Slow; streak	G.
14 19	4	309+45	192+57	65	Swift; streak	M.
14 35	4	205+50	186+34	21	,,	M.
14 50	4	309+45	192+57	65	,,	M.
14 54	2	230+60	182+42	34	,,	M.
15 5	2	14+88	165+45	48	,,	M.
15 5	2	257+66	187+42	44	,,	M.
May 6.						
14 20	1	353+43	27+70	32	Slow; streak	M.
14 23	2	336+47	28+81	38	,,	M.
May 8.						
14 30	1	309+45	199+56	64	,,	M.

The observers were: M., Maggi, Volpeglino; I., Jadanza, Napoli; Z., Zona, Padova; V., Volante, Aosta; Gi., Garibaldi, Genova; Ba., Battezzati, Alessandria; Bz., Barizzone, Alessandria; Ga., Gai, Alessandria; C., Crabbio, Alessandria; Be., Bellucci, Perugia; S., Sosso, Moncalieri; D., Denza, Moncalieri; G., Giovanola, Moncalieri.

Bristol: 1882, *Dec.* 18.

Observations of Phenomena of Jupiter's Satellites, made at the University Observatory, Durham, in the Year 1882. By G. A. Goldney.

(*Communicated by the Rev. Professor Farrar, D.D.*)

Day of Observation.	Satellite.	Phenomenon.	Power.	G.M. Solar Time of Observation. h m s	G.M. Solar Time of N.A.
Jan. 7	III.	Tr. Ingr. First contact	195	6 29 37	
		Bisection	,,	6 32 47	6 32
		Last contact	,,	6 38 12	
7	I.	Tr. Egr. First contact	,,	10 37 2	
		Bisection	,,	10 39 2	10 40
		Last contact	,,	10 40 32	
7	II.	Ecl. R. First seen	,,	12 24 20·3	12 24 30
17	I.	Ecl. R. First seen	,,	5 27 36·8	
		Full brightness	,,	5 29 25·3	5 27 36
22	I.	Occ. D. First contact	,,	9 24 5	
		Bisection	,,	9 25 35	9 26
		Last seen	,,	9 26 40	
22	I.	Ecl. R. First seen	,,	12 54 45·3	
		Full brightness	,,	12 57 9·3	12 54 30
23	I.	Tr. Ingr. First contact	,,	6 38 12	
		Bisection	,,	6 39 49	6 39
		Last contact	,,	6 42 16	
23	II.	Tr. Ingr. First contact	,,	7 9 3	
		Bisection	,,	7 11 13	7 16
		Last contact	,,	7 14 38	
23	I.	Tr. Egr. Bisection	135	8 51 38	
		Last contact	,,	8 53 48	8 51
23	II.	Tr. Egr. Bisection	,,	9 50 13	
		Last contact	,,	9 52 58	9 54
24	I.	Ecl. R. First seen	195	7 23 38·2	
		Full brightness	,,	7 25 30·2	7 23 33
Feb. 1	III.	Occ. D. First contact	,,	7 32 2	
		Bisection	,,	7 36 32	7 45
		Last seen	,,	7 41 2	
	II.	Occ. D. First contact	500	6 49 1	
		Bisection	,,	6 51 31	6 52
		Last seen	,,	6 54 21	
8	I.	Tr. Egr. First contact	,,	7 6 1	
		Bisection	,,	7 7 26	7 8
		Last contact	,,	7 9 11	

Day of Observation.	Satellite.	Phenomenon.	Power.	G.M. Solar Time of Observation. h m s	G.M. Solar Time of N.A.
Feb. 15	I.	Tr. Ingr. First contact	195	6 50 36	
		Bisection	,,	6 53 6	6 52
		Last contact	,,	6 56 36	
15	I.	Tr. Egr. Bisection	,,	9 4 41	
		Last contact	,,	9 6 26	9 5
15	II.	Occ. D. First contact	,,	9 23 1	
		Bisection	,,	9 25 11	9 29
		Last seen	,,	9 27 36	
16	I.	Ecl. R. First seen	,,	7 40 19·8	
		Full brightness	,,	7 41 30·8	7 40 20
19 (*a*)	III.	Tr. Egr. Bisection	270	8 5 35	
		Last contact	,,	8 8 15	8 8
Mar. 3 (*b*)	II.	Tr. Ingr. First contact	,,	9 48 6	
		Bisection	,,	9 51 6	9 54
		Last contact	,,	9 52 41	
5 (*c*)	II.	Ecl. R. First seen	,,	9 13 55·5	9 12 56
16	III.	Occ. D. First contact	195	8 39 25	
		Bisection	,,	8 41 25	8 44
		Last seen	,,	8 43 10	
21	II.	Tr. Egr. Bisection	,,	7 26 55	
		Last contact	,,	7 29 15	7 29
26 (*d*)	I.	Tr. Egr. First contact	135	7 57 11	
		Bisection	,,	7 59 31	7 59
		Last contact	,,	8 2 41	
Nov. 11	I.	Tr. Ingr. First contact	380	9 35 20	
		Bisection	,,	9 36 14	9 37
		Last contact	,,	9 37 53	
11	I.	Tr. Egr. First contact	,,	11 45 59	
		Bisection	,,	11 48 38	11 52
		Last contact	,,	11 50 37	
12 (*e*)	I.	Occ. R. Last contact	,,	8 59 34	8 59
17	I.	Ecl. D. First diminution	270	13 17 56 6	
		Fading rapidly	,,	13 18 42·6	13 20 33
		Last seen	,,	13 20 39·6	
25 (*f*)	I.	Tr. Ingr. First contact	,,	13 4 23	
		Bisection	,,	13 6 12	13 7
		Last contact	,,	13 8 26	

Day of Observation.	Satellite.	Phenomenon.	Power.	G.M. Solar Time of Observation. h m s	G.M. Solar Time of N.A.
Nov. 27 (*g*)	I.	Tr. Ingr. First contact	270	7 30 32	
		Bisection	„	7 32 17	7 33
		Last contact	„	7 33 42	
27	I.	Tr. Egr. First contact	„	9 45 37	
		Bisection	„	9 47 17	9 48
		Last contact	„	9 49 2	
28 (*h*)	II.	Occ. R. Bisection	„	6 53 53	
		Last contact	„	6 55 58	6 55
30 (*i*)	II.	Ecl. D. First diminution	„	9 48 17·1	
		Last seen	„	9 52 12·1	9 53 43
Dec. 10	III.	Tr. Ingr. First contact	„	7 59 35	
		Bisection	„	8 4 30	8 6
		Last contact	„	8 8 59	
10	III.	Sh. Egr. First contact	„	9 47 30	
		Bisection	„	9 50 35	9 56
		Last contact	„	9 54 15	
10	II.	Tr. Ingr. First contact	„	10 31 30	
		Bisection	„	10 36 45	10 42
		Last contact	„	10 43 0	
10	I.	Ecl. D. First diminution	„	13 29 42·5	
		Last seen	„	13 31 51·5	13 31 44
11	I.	Tr. Ingr. First contact	„	10 57 17	
		Bisection	„	10 58 54	11 0
		Last contact	„	11 1 6	
11	I.	Tr. Egr. First contact	„	13 10 7	
		Bisection	„	13 11 57	13 15
		Last contact	„	13 14 8	
21	I.	Ecl. R. First seen	„	6 35 1·7	
		Full brightness	„	6 36 57·7	6 34 51
23	II.	Tr. Ingr. First contact	380	11 28 16	
		Bisection	„	11 30 37	11 32
		Last contact	„	11 33 30	

Remarks.

(*a*) Very bad definition. (*b*) Images blurred; very bad definition.
(*c*) Rain falling; cloudy after. (*d*) Excessively bad definition.
(*e*) Bad definition. (*f*) Through thin cloud. Images very blurred.
(*g*) Very tremulous. (*h*) Cloudy; images very bad.
(*i*) Thin cloud; hazy.

The observations were all made with the Fräunhofer Equatorial, with an aperture of $6\frac{3}{8}$ inches.

Note upon the Longitudes of Madras, Singapore, and Batavia.

By Prof. J. A. C. Oudemans.

(*Communicated by J. R. Hind, F.R.S.*)

This summer I have at last received from Mr. Norman Pogson not only the necessary numbers for deducing the difference of longitude of Madras and Singapore, telegraphically determined by us in July 1871, but also the deduction of that longitude itself. My own calculation coincides wholly with his.

By proposing to Mr. Pogson the determination of the above-named difference of longitude, I intended to obtain a telegraphic longitude of Batavia as soon as the longitude of Madras should be telegraphically determined; the difference Batavia-Singapore having been determined already by me and Mr. Soeters half a year before.

I have now prepared a report on that determination, to be presented to the Dutch Colonial Government, and have sent a more detailed abstract of it to the editor of the *Astronomische Nachrichten*, so I will content myself with mentioning here only the result, viz. Singapore (flagstaff on Government Hill), east of Madras (Meridian Circle) $1^h\ 34^m\ 23^s{\cdot}635$, and to add that the personal equation between Mr. Pogson and myself has not been determined, so that it remains in the result.

The longitude of Madras formerly adopted in the *Nautical Almanac* was $5^h\ 20^m\ 57^s{\cdot}3$, but in that of 1882 it appears for the first time as $5^h\ 20^m\ 59^s{\cdot}4$, the "Explanation" printed after the *Almanac* not explaining this change. As this number is less by $0'{\cdot}25$ than that communicated by General Addison in the *Monthly Notices* of December 1877, I asked Mr. Hind for some information about the origin of the number in the *Nautical Almanac*. He most willingly answered me that the new longitude of Madras was communicated to him by Sir George Airy in a letter of 1878, January 25:—

		h	m	s
Transit of *Venus*.	Mokattam, East of Greenwich ...	2	5	6·320
	Suez, East of Mokattam ...	0	5	6·917
Indian Officers.	Aden, East of Suez	0	49	42·656
	Bombay, East of Aden ...	1	51	19·983
	Madras, East of Bombay ...	0	29	43·540
	Madras, East of Greenwich ...	5	20	59·416

and added, for further information, the following extract from Sir George Airy's letter:—

"Colonel Walker requests me to transmit to you for insertion (if you see no objection) in the *Nautical Almanac* the following determination of the longitude of Madras by telegraphic operations. The necessary observations were made by Captains W.

M. Campbell and Heaviside, R.E. I do not answer for the accuracy (indeed, I have not all the observations), but I remark that care was taken to determine personal equations and to observe stars on both sides of the zenith; and I have no doubt on the general excellence of the work. The work of the Indian observers was based on that of the Transit of Venus."

Now, the "Account of Observations of the Transit of Venus, 1874, December 8, &c.," edited by Sir George Biddell Airy, 1881, gives the first two of the above-named differences respectively $0^s.08$ smaller and $0^s.013$ larger. Though I judged for myself that this result being printed and probably of a later date ought to be preferred, I took the liberty to consult Sir George himself, whose answer was affirmative. Thus, taking the differences Mokattam-Greenwich and Suez-Mokattam from the "Account, &c.," we have:—

	h	m	s
Mokattam, East of Greenwich	2	5	6 24
Suez, East of Mokattam	0	5	6·93
Aden, East of Suez	0	49	42·656
Bombay, East of Aden	1	51	19·983
Madras, East of Bombay	0	29	43·540
Singapore, East of Madras	1	34	23·365
Batavia, East of Singapore	0	11	50·985

whence, by addition, east of Greenwich:

	h	m	s
Madras (Meridian Circle)	5	20	59·349
Singapore (flagstaff on Government Hill) ...	6	55	22·714
Batavia (time signal)	7	7	13·70

The new longitude of Batavia exceeds only by $1^s.20$ the former one, determined by me in 1858, chiefly by occultations of stars.

At Singapore the Government kindly erected a brick pillar for our observations north of the cathedral; besides its latitude we determined the relative positions of this pillar, the spire of the cathedral, and the flagstaff on Government Hill. The result was:—

		s
Pillar, east of flagstaff	21″·10 or	1·407
Spire „ „	18·48 or	1·232

	°	′	″	
Latitude of flagstaff	1	17	34·4	North.
„ spire	1	17	32·8	„
„ pillar	1	17	39·8	„

Utrecht: 1882, *Dec.* 27.

The Proper Motions of Telescopic Stars. By Professor Grant.

The work connected with the preparation of the Glasgow Star Catalogue has indicated the existence of several stars below the sixth magnitude having a considerable proper motion. It may be mentioned that the Catalogue contains 6415 stars, of which at least 5000 were taken for re-observation from the first volume of Weisse's Bessel. When the Glasgow results were finally worked out, it became an object of interest to institute a comparison between them and the corresponding results of the Catalogue from which they were originally derived. For this purpose the places in Weisse's Bessel were carefully brought up to 1870, the epoch of the Glasgow Catalogue, and the results in R.A. and N.P.D. of both Catalogues were then confronted together. In this way it was expected that any discordance in either or both of the co-ordinates, depending upon proper motion, would at once reveal itself. Although the agreement between the two Catalogues was on the whole very satisfactory, still a considerable number of discordances did present themselves, and the question now to be considered was whether those discordances were due to proper motion, or whether they were not in many instances attributable to errors of observation and reduction, arising from various sources. For this reason I made it a practice in every case of considerable discordance to search Lalande's *Histoire Céleste*, with the view of ascertaining whether the place of the star under consideration was also contained in that Catalogue. In this search I was generally successful; and if I found that the discordance of Bessel relatively to Glasgow was to the discordance of Lalande relatively to Glasgow, generally speaking, in the proportion of two to three, I concluded that I was really in the track of a proper motion. But to establish this point beyond doubt, it was necessary to ascertain the mean epochs of observation of Lalande and Bessel, an important element which is not contained either in the English edition of Lalande or in Weisse's Bessel. However, a reference to the *Histoire Céleste* and the volumes of the Königsberg Observations supplied me with the desired information. When I had finished the work of comparison, and ascertained beyond doubt the existence of several considerable proper motions in the Glasgow Catalogue, it occurred to me that it would be desirable to know whether the same, or nearly the same, results had been arrived at elsewhere. For this purpose I lately procured from the Library of the Society the seventh volume of the Bonn Observations, containing Argelander's remarkable list of proper motions, which I had not previously seen. Upon examination, I found that Nos. 14, 25, 30, 32, 33, 35, and 37 of the list here given had not escaped the lynx eye of the eminent astronomer of Bonn. I have also ascertained that No. 2 in the list is contained in the Melbourne Catalogue. Probably others in the list

have been already recognised, but I am not acquainted with any such. In a few instances the star is not to be found in Lalande, but an intercomparison of the Glasgow results will be seen to support the adopted P.M. Indeed, in some of the cases of large proper motion, the Glasgow places, ranging as they do over an interval of ten or twelve years, supply of themselves a pretty fair estimation of the proper motion. It will be seen with respect to the double stars 11–12 and 23–24 that the constituent bodies have in each case a common proper motion. They may, therefore, be regarded in both instances as physically connected. I have given in the list which follows: the number of Lalande, the hour and number of Bessel, the number of the Glasgow Catalogue, and the magnitude.

1. *Lalande*, 619; *W. B.* (1) 0,340; *Glasgow*, 123; *Mag.* 6–7.

	Mean Epoch of Obs.	Mean R.A. 1870.	Mean Epoch of Obs.	Mean N.P.D. 1870.
		h m s		° ′ ″
Lalande	1793·89	0 21 36·81	1793·89	80 31 3·56
Bessel	1821·83	37·09	1821·83	10·30
Glasgow	1868·45	36·91	1868·45	21·23

The proper motion in R.A. is uncertain, but obviously very small. With respect to the proper motion in N.P.D. we have—

Gl.—B.	+10″·93
Gl.—LL.	+17·67

Applying to the results in N.P.D. a proper motion equal to +0″·24, we have—

	Mean N.P.D. 1870.
	° ′ ″
LL.	80 3 21·93
B.	21·86
Gl.	21·60

2. *Lalande*, 1198; *W. B.* (1) 0,649; *Glasgow*, 125; *Mag.* 8.

	Mean Epoch of Obs.	Mean R.A. 1870	Mean Epoch of Obs.	Mean N.P.D. 1870
		h m s		° ′ ″
LL.	1794·90	0 38 25·16	1794·90	88 53 30·63
B.	1821·96	25·55	1821·96	53 52·00
Gl.	1871·91	25·01	1876·66	54 25·20

The P.M. in R.A. is insensible. With respect to the results in N.P.D., we have—

Gl.—B.	+33″·20
Gl.—LL.	+54·57

Applying to the results in N.P.D. a proper motion equal to $+0''\cdot60$, we have—

	Mean N.P.D. 1870.
LL.	88° 54′ 15″·68
B.	20·83
Gl.	21·20

The Glasgow N.P.D. results for the several years of observation are—

Year.	No. of Obs.	Mean N.P.D. 1870.	Corrected for P.M.
1870·94	2	88° 54′ 21″·15	88° 54′ 20″·59
1879·82	1	27·96	22·07
1880·81	2	27·86	21·37

As already stated, the place of this star is given in the Melbourne Catalogue. It is also contained in the Greenwich Catalogue for 1864. Reducing the Greenwich N.P.D. to 1870, and applying in both instances the P.M. above given, we have—

	Mean N.P.D. 1870.
Greenwich	88° 54′ 20″·93
Melbourne	21·68

3. *Lalande*, 3468; *W. B.* (1) I., 819; *Glasgow*, 407; *Mag.* 7.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870.
LL.	1798·93	1 46 31·51	1798·93	91° 56′ 58″·04
B.	1822·06	31·09	1822·06	57 10·05
Gl.	1872·60	30·54	1875·96	57 28·05

whence

	Mean R.A. s	Mean N.P.D.
Gl.—B.	0·55	+18″·00
Gl.—LL.	0·97	+30·01

Applying a proper motion equal to $-0^{s}\cdot013$ in R.A., and equal to $+0''\cdot36$ in N.P.D., we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870.
LL.	1 46 30·59	91° 57′ 23″·62
B.	30·47	27·31
Gl.	30·57	25·90

4. *Lalande*, 5353; *W. B.* (1) II., 795; *Glasgow*, 660; *Mag.* 7–8.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
LL.	1794·02	2 46 55·99	1794·02	88 33 14·31
B.	1821·96	55·62	1821·96	22·60
Gl.	1869·63	55·47	1879·33	33·64

whence

	Mean R.A. s	Mean N.P.D. ″
Gl.—B.	−0·15	+11·04
Gl.—LL.	−0·52	+19·33

Applying a proper motion equal to $-0^{s}\cdot006$ in R.A., and to $+0''\cdot20$ in N.P.D., we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
LL.... ...	2 46 55·54	88 33 29·51
B.	55·33	32·21
Gl.	55·47	31·17

5. *W. B.* (1) II., 927; *Glasgow*, 696; *Mag.* 8.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
B.	1822·86	2 53 36·31	1822·86	84 31 29·10
Gl.	1876·37	38·71	1877·88	36·75

whence

	R.A. s	N.P.D. ″
Gl.—B.	+2·40	+7·65

Applying a proper motion in R.A. equal to $+0^{s}\cdot075$, and in N.P.D. equal to $+0''\cdot14$ we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
B.	2 53 39·84	84 31 35·70
Gl.... ...	38·23	35·65

The Glasgow results for the several years are—

Year.	No. of Obs.	Mean R.A. 1870. h m s	Corrected for P.M. s	Year.	No. of Obs.	Mean N.P.D. 1870. ° ′ ″	Corrected for P.M. ″
1871·96	1	2 53 38·34	38·19	1871·96	1	84 31 36·28	36·01
1873·09	1	38·51	38·28	1878·84	1	35·47	34·23
9·77		38·91	38·18	1879·86	1	37·14	35·76
		39·07	38·27	1880·86	1	38·09	36·57

The value of P.M. in R.A. indicated by Gl.—B. is $+0^{s}\cdot045$. The value which has been assumed, namely $+0^{s}\cdot075$, appears to agree better with the separate Glasgow observations.

6. *W. B.* (1) III., 173; *Glasgow*, 763; *Mag.* 8.

	Mean Epoch of Obs.	Mean R.A. 1870.	Mean Epoch of Obs.	Mean N.P.D. 1870.
		h m s		° ′ ″
B.	1823·05	3 11 12·83	1823·05	75 17 11·00
Gl.	1871·61	12·71	1875·12	25·84

whence

	R.A.	N.P.D.
	s	″
Gl.—B. ...	= 0·12	+ 14·84

Applying to the N.P.D. results a proper motion equal to $+0''\cdot28$, we have—

	Mean N.P.D. 1870.
	° ′ ″
B.	75 17 24·15
Gl.	24·41

The Glasgow observations in N.P.D. of this star for the several years are—

Year.	No. of Obs.	Mean N.P.D. 1870.	Corrected for P.M.
		° ′ ″	″
1870·90	1	75 17 23·11	22·86
1871·01	1	25·52	25·24
1872·91	1	25·24	24·43
1879·88	1	28·24	25·47
1880·89	1	27·09	24·04

The Washington Catalogue also contains this star. Reducing the N.P.D. to 1870, and applying the above proper motion, we have—

Washington N.P.D. = $75^{\circ}\ 17'\ 23''\cdot87$

7. *Lalande*, 10299; *W. B.* (1) V., 512; *Glasgow*, 1341; *Mag.* 8.

	Mean Epoch of Obs.	Mean R.A. 1870.	Mean Epoch of Obs.	Mean N.P.D. 1870.
		h m s		° ′ ″
LL.	1797·14	5 22 1·18	1797·14	93 33 50·20
B.	1823·02	20 0·92	1823·02	34 8·00
Gl.	1876·89	21 59·53	1877·69	34 56·99

whence

		R.A.	N.P.D.
		s	″
Gl.—B.	...	= −1·39	+48·99
Gl.—LL.	...	= −1·65	+66·79

Applying a proper motion equal to −0ˢ·021 in R.A., and to +0″·85 in N.P.D., we have—

		Mean R.A. 1870.	Mean N.P.D. 1870.
		h m s	° ′ ″
LL.	...	5 22 59·65	93 34 52·13
B.	...	59·93	47·93
Gl.	...	59·67	50·45

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870.	Corrected for P.M.	Year.	No. of Obs.	Mean N.P.D. 1870.	Corrected for P.M.
		h m s	s			° ′ ″	″
1870·82	1	5 21 59·62	59·64	1872·82	1	93 34 52·33	49·93
1879·80	1	59·51	59·71	1878·94	2	58·33	50·73
1880·04	1	59·45	59·66	1880·04	1	58·98	50·45

8. *W. B.* (1) V., 625; *Glasgow*, 1355; *Mag.* 8.

	Mean Epoch of Obs.	Mean R.A. 1870.	Mean Epoch of Obs.	Mean N.P.D. 1870.
		h m s		° ′ ″
B.	1882·01	5 26 20·25	1822·01	86 58 9·30
Gl.	1873·69	20·19	1873·06	57 53·11

whence

		R.A.	N.P.D.
		s	″
Gl.—B.	...	= −0·06	−16·19

Applying to the N.P.D. results a proper motion equal to −0″·31, we have—

			Mean N.P.D. 1870.
			° ′ ″
B.	...	...	86 57 53·94
Gl.	...	...	54·09

The Glasgow results in N.P.D. for the several years are—

Year.	No. of Obs.	Mean N.P.D. 1870.	Corrected for P.M.
		° ′ ″	″
1867·15	1	86 57 54·24	53·33
1873·17	1	52·12	53·13
1878·87	1	52·98	55·82

9. *Lalande*, 11327; *W. B.* (1) V., 1305; *Glasgow*, 1477; *Mag.* 7–8.

	Mean Epoch of Obs.	Mean R.A. 1870.	Mean Epoch of Obs.	Mean N.P.D. 1870.
		h m s		° ′ ″
LL.	1797·14	5 51 55·36	1797·14	94 39 15·04
B.	1824·05	55·48	1824·05	18·70
Gl.	1876·96	55·44	1876·46	31·62

whence

	R.A.	N.P.D.
	s	″
Gl.—B. ...	−0·04	+12·92
Gl.—LL. ...	+0·08	+16·58

Applying to the results in N.P.D. a proper motion equal to +0″·22, we have—

	Mean N.P.D. 1870.
	° ′ ″
LL.	94 39 31·07
B.	28·81
Gl.	30·20

10. *Lalande*, 17046; *W. B.* (1) VIII., 828; *Glasgow*, 2205; *Mag.* 8.

	Mean Epoch of Obs.	Mean R.A. 1870.	Mean Epoch of Obs.	Mean N.P.D. 1870.
		h m s		° ′ ″
LL.	1796·20	8 32 45·28	1796·20	77 59 32·42
B.	1822·24	44·46	1822·24	77 59 48·00
Gl.	1868·17	44·30	1868·17	78 0 10·44

whence

	R.A.	N.P.D.
	s	″
Gl.—B. ...	−0·16	+22·44
Gl.—LL. ...	−0 98	+38·02

The proper motion in R.A. is uncertain; a comparison of Glasgow with Bessel gives −0ˢ·004. On the other hand, a comparison of Glasgow with Lalande gives −0ˢ·013. Applying to the results in N.P.D. a proper motion equal to +0″·50, we have—

	Mean N.P.D. 1870.
	° ′ ″
LL.	78 0 9·34
B.	11·88
Gl.	11·35

11. *Lalande*, 17050; *W. B.* (1) VIII., 834; *Glasgow*, 2206; *Mag.* 8.

12. *Lalande*, 17053; *W. B.* (1) VIII., 835; *Glasgow*, 2207; *Mag.* 9.

These two stars constitute a double star, and an intercomparison of the observations would seem to prove beyond doubt the existence of a physical connection between them. As this is a question of peculiar interest, I have searched out, not without success, other authorities for the places of the stars. I find that the places of both stars are contained in the Greenwich twelve-year Catalogue (Nos. 771–2). Struve has also recorded the relative position of the two stars in the *Mensuræ Micrometricæ* (p. 191); and he has given the absolute position of Lalande 17050 in the *Positiones Mediæ* (No. 1022). Considering first Lalande 17050, we have the following places of the star reduced to 1870:—

	Mean Epoch of Obs.	Mean R.A. 1870.	Mean Epoch of Obs.	Mean N.P.D. 1870.
		h m s		° ′ ″
LL.	1797·14	8 32 48·02	1797·14	83 45 45·52
B.	1822·12	48·27	1822·12	54·00
Struve	1823·40	48·14	1823·40	52·30
Greenwich	1845·25	48·28	1845·25	58·87
Glasgow	1868·21	48·50	1874·79	69·33

whence

	R.A. s	N.P.D. ″
Gl.—B. ...	= +0·23	+15·33
Gl.—LL. ...	= +0·48	+23·81

Assuming a proper motion in R.A. equal to $+0^{s}\cdot006$, and in N.P.D. to $+0''\cdot30$, we have—

	Mean R.A. 1870.	Mean N.P.D. 1870.
	h m s	° ′ ″
LL. ...	8 32 48·46	83 46 7·38
B. ...	48·56	8·37
Struve ...	48·42	6·28
Greenwich ...	48·43	6·37
Glasgow ...	48·47	7·73

Again, with respect to Lalande 17053, we have—

	Mean Epoch of Obs.	Mean R.A. 1870.	Mean Epoch of Obs.	Mean N.P.D. 1870.
		h m s		° ′ ″
LL.	1797·14	8 32 48·72	1797·14	83 45 21·72
B.	1822·12	49·23	1822·12	31·50
Greenwich	1845·25	49·31	1845·25	36 30
Glasgow	1872·43	49·60	1874·75	45·95

Applying a proper motion equal to +0·006 in R.A., and to +0″·30 in N.P.D., we have—

	Mean R.A. 1870	Mean N.P.D. 1870
	h m s	° ′ ″
LL. ...	8 32 49·16	83 45 43·58
B. ...	49·52	45·87
Greenwich ...	49·46	43 72
Glasgow ...	49·57	44·53

It appears, then, that the same proper motion is capable of representing the secular changes in the places of both stars.

13. *W. B.* (1) VIII., 961; *Glasgow*, 2235; *Mag.* 7.

	Mean Epoch of Obs.	Mean R.A. 1870.	Mean Epoch of Obs.	Mean N.P.D. 1870.
		h m s		° ′ ″
B.	1824·17	8 37 34·07	1824·17	93 43 46″30
Gl.	1873·37	33·92	1873·11	44 5·47

whence

	R.A.	N.P.D.
	s	″
Gl.—B.	−0·15	+19·17

Applying a proper motion equal to −0ˢ·003 in R.A., and to +0″·40 in N.P.D., we have—

	Mean R.A. 1870.	Mean N.P.D. 1870.
	h m s	° ′ ″
B.	8 37 33·93	93 44 4·63
Gl.	33·93	4·23

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870.	Corrected for P.M.	Year.	No. of Obs.	Mean N.P.D. 1870.	Corrected for P.M.
		h m s	s			° ′ ″	″
1868·13	1	8 37 33·86	33·86	1868·13	1	93 44 3·56	4·31
1873·12	1	33·98	33·99	1873·12	1	6·14	4·89
1874·13	1	34·03	34·04	1878·09	1	6·70	3·46
1878·09	1	33·82	33·84				

14. *Lalande*, 20100; *W. B.* (1) X., 240; *Glasgow*, 2693; *Mag.* 7–8.

	Mean Epoch of Obs.	Mean R.A. 1870.	Mean Epoch of Obs.	Mean N.P.D. 1870.
		h m s		° ′ ″
LL.	1796·20	10 15 14·57	1796·20	78 1 1·25
B.	1822·32	14·61	1822·32	6·20
Gl.	1873·49	14·43	1877·11	29·21

whence

	R.A.	N.P.D.
	s	″
Gl.—B.	−0·18	+23·01
Gl.—LL.	−0·14	+27·96

Applying a proper motion equal to −0ˢ·003 in R.A., and to +0″·40 in N.P.D., we have—

	Mean R.A. 1870.	Mean N.P.D. 1870.
	h m s	° ′ ″
LL.	10 15 14·35	78 1 30·77
B.	14·44	25·27
Gl.	14·44	26·37

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870.	Corrected for P.M.	Year.	No. of Obs.	Mean N.P.D. 1870.	Corrected for P.M.
		h m s	s			° ′ ″	″
1867·20	1	10 15 14·36	14·35	1873·12	1	78 1 27·97	26·72
1873·12	1	14·49	14·50	1878·29	1	29·00	25·68
1880·15	1	14·45	14·48	1879·91	1	30·67	26·71

15. *Lalande*, 20155; *W. B.* (1) X., 272; *Glasgow*, 2702; *Mag.* 8.

	Mean Epoch of Obs.	Mean R.A. 1870.	Mean Epoch of Obs.	Mean N.P.D. 1870.
		h m s		° ′ ″
LL.	1798·19	10 17 1·70	1798·19	86 42 34·42
B.	1823·27	1·54	1823·27	42.20
Gl.	1870·16	1·17	1874·38	55·03

whence

	R.A.	N.P.D.
	s	″
Gl.—B.	−0·37	+12·83
Gl.—LL.	−0·53	+20·61

Applying a proper motion equal to −0ˢ·007 in R.A., and to +0″·26 in N.P.D., we have—

	Mean R.A. 1870.	Mean N.P.D. 1870.
	h m s	° ′ ″
LL.	10 17 1·20	86 42 53·09
B.	1·21	54·35
Gl.	1·17	53·89

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870.	Corrected for P.M.	Year.	No. of Obs.	Mean N.P.D. 1870.	Corrected for P.M.
		h m s	s			° ′ ″	″
1867·16	1	10 17 1·12	1·10	1867·16	1	86 42 54·12	53·38
1873·16	1	1·22	1·24	1873·16	1	53·31	54·13
				1878·59	2	56·34	54·11

16. *Lalande*, 20679; *W. B.* (1) X., 633; *Glasgow*, 2783; *Mag.* 7.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
LL.	1795·25	10 36 10·98	1795·25	91 29 28·81
B.	1822·28	11·09	1822·28	37·40
Gl.	1875·79	11·02	1872·02	48·47

whence

	R.A. s	N.P.D. ″
Gl.—B.	−0·07	+11·07
Gl.—LL.	+0·04	+19·66

Applying a proper motion equal to +0″·24 in N.P.D., we have—

	Mean N.P.D. 1870. ° ′ ″
LL.	91 29 46·75
B.	48·85
Gl.	47·99

The Glasgow N.P.D. results for the several years are—

Year.	No. of Obs.	Mean N.P.D. 1870. ° ′ ″	Corrected for P.M. ″
1869·24	2	91 29 48·52	48·70
1871·32	1	47·78	47·46
1878·26	1	49 07	47·09

17. *Lalande*, 20882; *W. B.* (1) X., 782; Glasgow, 2809; *Mag.* 7–8.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
LL.	1796·26	10 44 25·60	1796·26	80 4 28·81
B.	1822·24	25·57	1822·24	36·00
Gl.	1880·20	25·46	1877·62	49·69

whence

	R.A. s	N.P.D. ″
Gl.—B. ...	−0·11	+13·69
Gl.—LL. ...	−0·14	+20·88

Applying a proper motion equal to −0ˢ·001 in R.A., and to +0″·25 in N.P.D., we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
LL. ...	10 44 25·53	80 4 47·14
B. ...	25·52	47·94
Gl. ...	25·46	47·79

The Glasgow N.P.D. results for the several years are—

Year.	No. of Obs.	Mean N.P.D. 1870.	Corrected for P.M.
1870·22	1	80° 4′ 47″·94	47″·89
1879·91	1	49·91	47·43
1880·18	2	50·46	47·92

18. *Lalande*, 21586; *W. B.* (1) XI., 193; *Glasgow*, 2920; *Mag.* 7–8.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870.
LL.	1796·27	11 12 47·09	1796·27	90° 56′ 7″·43
B.	1823·27	46·74	1823·27	14·30
Gl.	1874·68	45·68	1876·95	20·66

whence

	R.A. s	N.P.D.
Gl.—B.	−1·06	+6″·36
Gl.—LL.	−1·41	+13·23

Applying a proper motion equal to −0ˢ·020 in R.A., and to +0″·14 in N.P.D., we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870.
LL. ...	11 12 45·52	90° 56′ 17″·75
B. ...	45·81	20·84
Gl. ...	45·77	19·69

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870. h m s	Corrected for P.M. s	Year.	No. of Obs.	Mean N.P.D. 1870.	Corrected for P.M.
1872·35	3	11 12 45·78	45·83	1872·32	1	90° 56′ 19″·26	18″·94
1875·18	2	45·63	45·73	1878·23	1	21·24	20·09
1877·14	1	45·66	45·80	1880·29	1	21·47	20·03
1878·23	1	45·53	45·69				

19. *Lalande*, 22385; *W. B.* (1) XI., 774; *Glasgow*, 3049; *Mag.* 7–8.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870.
LL.	1796·26	11 45 44·53	1796·26	79° 20′ 4″·89
B.	1822·23	43·83	1822·23	20 3·00
Gl.	1877·25	42·72	1877·47	19 58·48

whence

	R.A.	N.P.D.
	s	″
Gl.—B.	−1·11	−4·52
Gl.—LL.	−1·81	−6·41

Applying a proper motion equal to $-0^{s}\cdot020$ in R.A., and to $-0''\cdot08$ in N.P.D., we have—

	Mean R.A. 1870.	Mean N.P.D. 1870.
	h m s	° ′ ″
LL. ...	11 45 43·06	79 20 58·99
B. ...	42·88	59·18
Gl. ...	42·87	59·08

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870.	Corrected for P.M.	Year.	No. of Obs.	Mean N.P.D. 1870.	Corrected for P.M.
		h m s	s			° ′ ″	″
1873·12	1	11 45 42·74	42 80	1873·12	1	79 19 57·16	57·41
1876·28	1	42·73	42·85	1878·26	2	59·00	59·66
1878·27	1	42·91	43·07	1880·22	1	58·77	59·59
1879·29	2	42·61	42·79				

20. *Lalande*, 22901; *W. B.* (1) XII., 75; *Glasgow*, 3122; *Mag.* 8.

	Mean Epoch of Obs.	Mean R.A. 1870.	Mean Epoch of Obs.	Mean N P.D. 1870.
		h m s		° ′ ″
LL.	1796·26	12 6 16·28	1796·26	79 13 2·91
B.	1824·25	17·25	1824·25	18·70
Gl.	1877·59	17·71	1878·32	37·69

whence

	R.A.	N.P.D.
	s	″
Gl.—B.	= +0·46	+18·99
Gl.—LL.	= +1·43	+34·78

Applying a proper motion equal to $+0^{s}\cdot006$ in R.A., and to $+0''\cdot38$ in N.P.D., we have—

	Mean R.A. 1870.	Mean N.P.D. 1870.
	h m s	° ′ ″
LL.	12 6 16·94	79 13 30·93
B.	17·66	36·08
Gl.	17·64	34·53

21. *Lalande*, 22908; *W. B.* (1) XII., 77; *Glasgow*, 3123; *Mag.* 7.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
LL.	1798·27	12 6 34·85	1798·27	78 25 22·64
B.	1823·24	34·56	1823·24	25 34·50
Gl.	1874·48	35·07	1875 91	26 6·33

whence

	R.A. s	N.P.D. ″
Gl.—B.	= +0·51	+31·83
Gl.—LL.	= +0·22	+43·69

Applying a proper motion equal to +0ˢ·010 in R.A., and to +0″·58 in N.P.D., we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
LL.	12 6 35·57	78 26 4·24
B.	35·02	1·62
Gl.	35·03	2·90

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870. h m s	Corrected for P.M. s	Year.	No. of Obs.	Mean N.P.D. 1870. ° ′ ″	Corrected for P.M. ″
1867·29	1	12 6 34·94	34·97	1867·29	1	78 26 1·69	2·26
1870·26	1	34·98	34·98	1870·25	1	2·23	2·09
1873·16	1	35·11	35·08	1880·33	2	9·54	3·55
1880·32	1	35·03	34·93	1881·37	1	8·64	2·05
1881·35	1	35·27	35·16				

22. *Lalande*, 22914; *W. B.* (1) XII., 80; *Glasgow*, 3126; *Mag.* 7–8.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
LL.	1796·26	12 6 51·22	1796·26	79 13 5·84
B.	1824·25	51·26	1824·25	19·05
Gl.	1873·77	51·45	1879·30	34·61

whence

	R.A. s	N.P.D. ″
Gl.—B.	= +0·19	+15·56
Gl.—LL.	= +0·23	+28·77

Applying a proper motion equal to $+0^{s}\cdot003$ in R.A., and to $+0''\cdot31$ in N.P.D., we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
LL.	12 6 51·44	79 13 28·70
B.	51·40	33·23
Gl.	51·44	31·73

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870. h m s	Corrected for P.M. s	Year.	No. of Obs.	Mean N.P.D. 1870. ° ′ ″	Corrected for P.M. ″
1869·30	1	12 6 51·45	51·45	1878·26	2	79 13 34·21	31·65
1878·23	1	51·45	51·43	1880·30	2	35·01	31·81

23. *W. B.* (1) XIII., 257; *Glasgow*, 3367; *Mag.* 8.

24. *W. B.* (1) XIII., 259; *Glasgow*, 3368; *Mag.* 8.

These two stars constitute a double star, and as they appear to have a common proper motion, we may presume that there exists between them a physical connection. Their relative position is given in Struve's *Mensuræ Micrometricæ* (p. 192), and the absolute position of the former is contained in the *Pos. Med.* (No. 1517). Taking the case of the first star, we have—

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
B.	1822·36	13 17 2·90	1822·36	86 36 25·45
Gl.	1874·91	2·78	1873·99	13·16

whence

	R.A. s	N.P.D. ″
Gl.—B.	−0·12	−12·29

Applying a proper motion equal in R.A. to $-0^{s}\cdot002$, and in N.P.D. to $+0''\cdot24$, we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
B.	13 17 2·81	86 36 14·02
Gl.	2·79	14·12

The mean epoch of Struve's observation of the star is 1823·70, and the position similarly reduced to 1870 is—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
Struve	13 17 2·63	86 36 13·87

With respect to the second star we have—

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
B.	1822·36	13 17 4·34	1822·36	86 36 18″·80
Gl.	1879·73	4·51	1878·37	6 12

whence

	R.A. s	N.P.D. ″
Gl.—B.	+0·17	−12·68

Applying the proper motion found for the first star we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
B.	13 17 4·25	86 36 5·36
Gl.	4·53	4·11

25. *Lalande*, 25404; *W. B.* (1) XIII., 679; *Glasgow*, 3438; *Mag.* 6.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
LL.	1797·28	13 40 33·43	1797·28	82 59 32″·74
B.	1823·31	32·34	1823·31	35·10
G.	1872·27	30·94	1873 62	41·35

whence

	R A. s.	N.P.D. ″
Gl.—B.	−1·40	+6·25
Gl.—LL.	−2·49	+8·61

Applying a proper motion equal to $-0^{s}\cdot030$ in R.A., and to $+0''\cdot10$ in N.P.D., we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
LL.	13 40 31·25	82 59 41″·47
B.	30·90	40·70
Gl.	30·87	40·92

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870. h m s	Corrected for P.M. s	Year.	No. of Obs.	Mean N.P.D. 1870. ° ′ ″	Corrected for P.M. ″
1871·28	2	13 40 30·87	30·90	1871·28	2	82 59 41″·44	41″·31
1874·26	1	31·09	31·22	1878·31	1	41·18	40·35

26. *Lalande*, 26042; *W. B.* (1) XIV., 74; *Glasgow*, 3524; *Mag.* 8–9.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
LL.	1795·35	14 6 3·13	1795·35	92 41 23·54
B.	1822·34	2·84	1822·34	36·50
Gl.	1878·77	2·04	1880·12	52·92

whence

	R.A. s	N.P.D. ″
Gl.—B. ...	−0 80	+16·42
Gl.—LL. ...	−1 09	+29·38

Applying a proper motion equal to $-0^{s}\cdot015$ in R.A., and to $+0''\cdot32$ in N.P.D., we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
LL.	14 6 2·01	92 41 47·43
B.	2·13	51 75
Gl.	2·17	49·68

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870. h m s	Corrected for P.M. s	Year.	No. of Obs.	Mean N.P.D. 1870. ° ′ ″	Corrected for P.M. ″
1872·39	1	14 6 2·25	2 28	1878·24	2	92 41 51·17	48·53
1880·23	1	2·03	2·18	1880·28	2	54·13	50·84
1881·23	2	1·94	2·11	1881·26	3	53·29	49·69

27. *Lalande*, 26289; *W. B.* (1) XIV., 281; *Glasgow*, 3562; *Mag.* 6.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
LL.	1797·39	14 16 35·44	1797·39	88 8 16·75
B.	1822·39	36·30	1822·39	32·00
Gl.	1872·33	36·53	1878·08	57·49

whence

	R.A. s	N.P.D. ″
Gl.—B.	+0·23	+25·49
Gl.—LL.	+1·09	+40·74

Applying a proper motion equal to $+0^{s}\cdot005$ in R.A., and to $+0''\cdot48$ in N.P.D., we have—

	Mean R.A. 1870	Mean N.P.D. 1870
	h m s	° ′ ″
LL.	14 16 35·80	88 8 51·60
B.	36·54	54·85
Gl.	36·52	53·61

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870.	Corrected for P.M.	Year.	No. of Obs.	Mean N.P.D. 1870.	Corrected for P.M.
		h m s	s			° ′ ″	″
1871·35	1	14 16 36·50	36·50	1873·30	1	88 8 56·13	54·55
1873·30	1	36·56	36·54	1878·38	1	56·98	52·96
				1880·32	2	58·43	53·48

28. *Lalande*, 27331; *W. B.* (1) XIV., 1005; *Glasgow*, 3703; *Mag.* 7–8.

	Mean Epoch of Obs.	Mean R.A. 1870.	Mean Epoch of Obs.	Mean N.P.D. 1870.
		h m s		° ′ ″
LL.	1799·40	14 54 15·64	1799·40	80 51 51·42
B.	1823·37	15·82	1823·37	51 59·00
Gl.	1874·32	15·37	1877·15	52 18·46

whence

	R.A.	N.P.D.
	s	″
Gl.—B.	−0·45	+19·46
Gl.—LL.	−0·27	+27·04

Applying a proper motion equal to $-0^{s}\cdot010$ in R.A., and to $+0''\cdot36$ in N.P.D., we have—

	Mean R.A. 1870.	Mean N.P.D. 1870.
	h m s	° ′ ″
LL.	14 54 14·93	80 51 16·84
B.	15·36	15·79
Gl.	15·33	15·89

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870.	Corrected for P.M.	Year.	No. of Obs.	Mean N.P.D. 1870.	Corrected for P.M.
		h m s	s			° ′ ″	″
1868·41	1	14 54 15·34	15·32	1868·41	1	80 52 15·19	15·76
1874·33	3	15·40	15·44	1878·39	2	18·86	15·84
1880·21	1	15·31	15·41	1880·28	2	19·69	15·99

29. *Lalande*, 27468; *W. B.* (1) XIV., 1090; *Glasgow*, 3717; *Mag.* 8.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
LL.	1797·36	14 58 48·12	1797·36	83 11 16·54
B.	1823·41	48·18	1823·41	25·10
Gl.	1878·35	48·03	1876·06	40·01

whence

	R.A. s	N.P.D. ″
Gl.—B.	−0·15	+14·91
Gl.—LL.	−0·10	+23·47

Applying a proper motion equal to $-0^{s}\cdot002$ in R.A., and $+0''\cdot32$ in N.P.D., we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
LL.	14 58 47·98	83 11 39·06
B.	48·09	39·54
Gl.	48·05	38·13

30. *Lalande*, 27744; *W. B.* (1) XV., 99; *Glasgow*, 3752; *Mag.* 6–7.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
LL.	1798·32	15 7 25·84	1798·32	90 50 5·81
B.	1822·44	23·86	1822·44	25·30
Gl.	1878·10	19·16	1878·30	49 67

whence

	R.A. s	N.P.D. ″
Gl.—B.	−4·70	+24·37
Gl.—LL.	−6·68	+43·86

Applying a proper motion equal to $-0^{s}\cdot085$ in R.A., and to $+0''\cdot55$ in N.P.D., we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
LL.	15 7 19·75	90 50 45·23
B.	19·82	51·35
Gl.	19·85	45·11

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870. h m s	Corrected for P.M.	Year.	No. of Obs.	Mean N.P.D. 1870. ° ′ ″	Corrected for P.M.
1871·38	2	15 7 19·81	19·93	1871·38	2	90 50 45·81	45·05
1878·26	1	18·98	19·68	1878·26	1	48·81	45·27
1879·29	3	19·08	19·87	1880·21	1	51·36	45·75
1881·35	3	18·85	19·81	1881·29	4	51·40	45·19

31. *W. B.* (1) XV., 583; *Glasgow*, 3845; *Mag.* 8.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
B.	1823·40	15 31 43·94	1823·40	79 18 49·50
Gl.	1876·09	44·42	1876·93	19 12·70

whence

	R.A. s	N.P.D. ″
Gl.—B.	+0·48	+23·20

Applying a proper motion equal to +0ˢ·010 in R.A., and to +0″·43 in N.P.D., we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
B.	15 31 44·41	79 18 9·45
Gl.	44·36	9·72

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870. h m s	Corrected for P.M. s	Year.	No. of Obs.	Mean N.P.D. 1870. ° ′ ″	Corrected for P.M. ″
1868·46	1	15 31 44·34	44·35	1868·46	1	79 19 8·45	9·11
1872·38	1	44·28	44·26	1872·38	1	10·62	9·60
1873·38	1	44·39	44·36	1873·38	1	9·59	8·14
1874·35	1	44·31	44·27	1880·21	1	14·88	10·49
1881·35	3	44·54	44·43	1881·35	3	15·13	10·25

32. *Lalande*, 29437; *W. B.* (1) XVI., 14; *Glasgow*, 3978; *Mag.* 6.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
LL.	1797·36	16 2 46·05	1797·36	83 14 2·06
B.	1823·41	46·60	1823·41	23·80
Gl.	1876·22	47·41	1877·20	63·41

whence

			R.A. s	N.P.D. ″
Gl.—B.	...	...	= +0·81	+39·61
Gl.—LL.	...	...	= +1·36	61·35

Applying a proper motion equal to $0^{s}\cdot016$ in R.A., and to $+0''\cdot72$ in N.P.D., we have—

			Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
LL.	...	...	16 2 47·21	83 14 54·36
B.	...	...	47·34	57·35
Gl.	...	...	47·31	58·23

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870. h m s	Corrected for P.M. s	Year.	No. of Obs.	Mean N.P.D. 1870. ° ′ ″	Corrected for P.M. ″
1867·42	1	16 2 47·28	47·32	1867·42	1	83 14 55·71	57·57
1871·39	1	47·37	47·35	1871·39	1	58·67	57·67
1877·44	1	47·40	47·28	1878 39	1	64·68	58·64
1878·39	1	47·48	47·35	1880·30	2	65·67	58·25
1881·35	2	47·46	47·28	1881·30	2	66·73	58·59

33. *Lalande*, 30044; *W. B.* (1) XVI., 439; *Glasgow*, 4066; *Mag.* 7.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
LL.	1794·48	16 24 7·11	1794·48	85 27 22·86
B.	1822·45	6·52	1822·45	28 6·60
Gl.	1874·39	4·71	1876·07	29 20·66

whence

			R.A. s	N.P.D. ″
Gl. –B.	...	...	−1·81	+74·06
Gl.—LL.	...	...	−2·40	117·80

Applying a proper motion equal in R.A. to $-0^{s}\cdot030$, and in N.P.D. to $1''\cdot42$, we have—

		R.A. 1870. h m s	N.P.D. 1870. ° ′ ″
LL.	...	16 24 4·70	85 29 10·10
B.	...	5·00	13·06
Gl.	...	4·85	12·04

The Glasgow results for the several years of observation are—

Year.	No. of Obs.	Mean R.A. 1870. h m s	Corrected for P.M. s	Year.	No. of Obs.	Mean N.P.D. 1870. ° ′ ″	Corrected for P.M. ″
1868·46	1	16 24 4·74	4·79	1868·46	1	85 29 8·60	10·79
1869·44	1	4·94	4·76	1869·44	1	10·48	11·17
1871·35	1	4·75	4·79	1871·35	1	13·57	11·65
1881·34	2	4·56	4·92	1880·29	2	26·94	12·33
				1881·34	2	29·05	12·95

34. *Lalande*, 30338; *W. B.* (1) XVI., 644; *Glasgow*, 4112; *Mag.* 7.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
LL.	1798·44	16 34 21·71	1798·44	92 34 36·97
B.	1823·06	21·29	1823·06	52·80
Gl.	1871·89	21·16	1874·09	75·43

whence

	R.A. s	N.P.D. ″
Gl.—B.	= −0·13	+22·63
Gl.—LL.	= −0·55	+38·46

Applying a proper motion equal to $0^s·005$ in R.A., and to $+0''·47$ in N.P.D., we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
LL.	16 34 21·36	92 35 10·60
B.	21·05	14·86
Gl.	21·16	13·51

35. *Lalande*, 30694; *W. B.* (1) XVI., 873; *Glasgow*, 4162; *Mag.* 6–7.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
LL.	1798·32	16 46 29·41	1798·32	89 43 29·85
B.	1822·44	27·84	1822·44	44 2·00
Gl.	1878·60	25·43	1878·42	45 29·11

whence

	R.A. s	N.P.D. ′ ″
Gl.—B.	= −2·41	+1 27·11
Gl.—LL.	= −3·98	+1 59·26

Applying a proper motion equal to $-0^{s}\cdot045$ in R.A., and to $+1''\cdot47$ in N.P.D, we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
LL.	16 46 26·33	89 45 15·22
B.	25·80	11·91
Gl.	25·80	16 73

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870. h m s	Corrected for P.M. s	Year.	No. of Obs.	Mean N.P.D. 1870. ° ′ ″	Corrected for P.M. ″
1867·46	1	16 46 25·90	25·81	1867·46	1	89 45 11·39	15·10
1872·41	1	25·49	25·59	1872·41	1	20·20	16·66
1876·54	2	25·51	25·79	1878·31	1	29·96	17·75
1878·31	1	25·40	25·77	1880·26	3	31 49	16·41
1880·26	3	25·34	25·78	1881·32	4	33·76	17·12
1881·32	3	25·30	25 79				

36. *Lalande*, 31065; *W. B.* (1) XVI., 1089; *Glasgow*, 4203; *Mag.* 6.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
LL.	1779·39	16 58 39·54	1797·39	89 5 48·38
B.	1822·44	39·84	1822·44	54·00
Gl.	1869·13	39·79	1869·13	75·14

whence

	R.A. s	N.P.D. ″
Gl.—B.	= −0 05	+21·14
Gl.—LL.	= +0·25	+26·76

The proper motion in R.A. is insensible. Applying a proper motion equal to $+0''\cdot41$ in N.P.D., we have—

	Mean N.P.D. 1870. ° ′ ″
LL.	89 6 18·15
B.	13·50
Gl.	15·50

37. *W. B.* (1) XVII., 322; *Glasgow*, 4294; *Mag.* 7.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
B.	1822·50	17 19 19·38	1822·50	87 42 43·50
Gl.	1879·54	16·94	1879·36	43 52·82

whence

	R.A. s	N.P.D. ′ ″
Gl.—B.	= −2·44	+1 9·32

Applying a proper motion equal to −0ˢ·043 in R.A., and to +1″·22 in N.P.D., we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
B.	17 19 17·34	87 43 41·45
Gl.	17·35	41·40

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870. h m s	Corrected for P.M. s	Year.	No of Obs.	Mean N.P.D. 1870. ° ′ ″	Corrected for P.M. ″
1871·43	1	17 19 17·23	17·29	1871·43	1	87 43 44·15	42·41
1880·25	4	16·93	17·38	1878·48	2	51·27	40·93
1881·30	3	16·85	17·33	1880·25	4	53·71	41·20
				1881·40	3	55·55	41·65

38. *W. B.* (1) XVII., 514; *Glasgow*, 4330; *Mag.* 8–9.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
B.	1822·48	17 28 27·19	1822·48	83 54 53·55
Gl.	1878·96	25·51	1877·37	32·87

whence

	R.A. s	N.P.D. ″
Gl.—B.	= −1·68	−20·68

Applying a proper motion equal to −0ˢ·029 in R.A., and to −0″·40 in N.P.D., we have—

	Mean R.A. 1870. h m s	Mean N P.D. 1870. ° ′ ″
B.	17 28 25·67	83 54 35·49
Gl.	25·78	35·82

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870. h m s	Corrected for P.M.	Year.	No. of Obs.	Mean N.P.D. 1870. ° ′ ″	Corrected for P.M. ″
1871·41	1	17 28 25·76	25·80	1871·41	1	83 54 35·15	35·71
1880·34	2	25·45	25·76	1880·35	2	31·73	35·87
1881·35	2	25·44	25·78				

39. *W. B.* (1) XVII., 1005 ; *Glasgow*, 4426 ; *Mag.* 9.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
B.	1823·48	17 49 54·01	1823·48	91 22 54·90
Gl.	1878·70	53·51	1878·52	18·68

whence

	R.A. s	N.P.D. ″
Gl.—B.	= −0·50	−36·22

Applying a proper motion equal to $-0^{s}\cdot009$ in R.A., and to $-0''\cdot66$ in N.P.D., we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
B.	17 49 53·59	91 22 24·20
Gl.	53·59	24·30

The Glasgow places for the several years in R.A. are—

Year.	No. of Obs.	Mean R.A. 1870. h m s	Corrected for P.M. s
1876·55	2	17 49 53·60	53·66
1879·44	1	53·41	53·49
1880·48	2	53·47	53·56

40. *Lalande*, 37110 ; *W. B.* (1) XIX., 711 ; *Glasgow*, 4843 ; *Mag.* 7.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
LL.	1794·50	19 29 21·50	1794·50	90 10 15·44
B.	1821·63	21·69	1821·63	26·90
Gl.	1875·06	21·12	1879·06	51·14

whence

	R.A. s	N.P.D. ″
Gl.—B.	−0·57	+24·24
Gl.—LL.	−0·38	+35·70

Applying a proper motion equal to $-0^{s}\cdot010$ in R.A., and to $+0''\cdot42$ in N.P.D., we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
LL.	19 29 20·75	90 10 47·15
B.	21·21	47·21
Gl.	21·17	47·33

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870.	Corrected for P.M.	Year.	No. of Obs.	Mean N.P.D. 1870.	Corrected for P.M.
		h m s	s			° ′ ″	″
1871·60	1	19 29 21·14	21·16	1871·60	1	90 10 46·79	46·12
1878·52	1	21·09	21·17	1878·60	2	50·35	46·74
				1880·70	2	53·02	48·53
				1881.61	2	52·22	47.34

41. *Lalande*, 45165; *W. B.* (1) XXII., 1226; *Glasgow*, 606 4; *Mag.* 7.

	Mean Epoch of Obs.	Mean R.A. 1870.	Mean Epoch of Obs.	Mean N.P.D. 1870.
		h m s		° ′ ″
LL.	1793·84	22 58 42·47	1793·84	74 7 33·39
B.	1821·80	41·82	1821·80	39·70
Gl.	1879·86	41·00	1878·49	51·19

whence

	R.A.	N.P.D.
	s	″
Gl.—B.	−0·82	+11·49
Gl.—LL.	−1·47	+17·80

Applying a proper motion equal to $-0^{s}\cdot015$ in R.A., and to $+0''\cdot20$ in N.P.D., we have—

	Mean R.A. 1870.	Mean N.P.D. 1870.
	h m s	° ′ ″
LL.	22 58 41·33	74 7 48·62
B.	41·10	49·34
Gl.	41·15	49·49

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870.	Corrected for P.M.	Year.	No. of Obs.	Mean N.P.D. 1870.	Corrected for P.M.
		h m s	″			° ′ ″	″
1877·85	1	22 58 40·85	40·97	1877·91	1	74 7 49·88	48·30
1880·86	2	41·07	41·23	1878·78	2	51·85	50·09

42. *W. B.* (1) XXII., 1230; *Glasgow*, 6066; *Mag.* 7.

	Mean Epoch of Obs.	Mean R.A. 1870.	Mean Epoch of Obs.	Mean N.P.D. 1870.
		h m s		° ′ ″
B.	1822·80	22 58 53·90	1822·80	80 15 42·70
Gl.	1876·50	53·76	1877·50	9·17

whence

	R.A.	N.P.D.
	s	″
Gl.—B.	−0·14	−33·53

Applying a proper motion equal to $-0^{s}\cdot003$ in R.A., and to $-0''\cdot61$ in N.P.D., we have—

	Mean R.A. 1870.	Mean N.P.D. 1870.
	h m s	° ′ ″
B.	22 58 53·76	80 15 13·90
Gl.	53·77	13·74

The Glasgow places for the several years are—

Year.	No. of Obs.	Mean R.A. 1870. h m s	Corrected for P.M. s	Year.	No. of Obs.	Mean N.P.D. 1870. ° ′ ″	Corrected for P.M. ″
1872·63	1	22 58 53·77	53·78	1872·63	1	80 15 11·13	12·73
1876·71	1	53·91	53·93	1877·91	1	9·32	14·14
1877·85	1	53·71	53·73	1878·80	1	7·95	13·32
1878·80	1	53·66	53·69	1880·64	1	8·27	14·76

43. *Lalande*, 46572–3; *W. B.* (1) XXIII., 789; *Glasgow* 6297; *Mag.* 8.

	Mean Epoch of Obs.	Mean R.A. 1870. h m s	Mean Epoch of Obs.	Mean N.P.D. 1870. ° ′ ″
LL.	1795·76	23 39 41·76	1795·76	80 55 33·89
B.	1822·86	41·67	1822·86	38·70
Gl.	1870·94	41·48	1873·55	50·23

whence

	R.A. s	N.P.D. ″
Gl.—B.	−0·19	+11·53
Gl.—LL.	−0·28	+16·34

Applying a proper motion equal to $-0^{s}\cdot004$ in R.A., and to $+0''\cdot22$ in N.P.D., we have—

	Mean R.A. 1870. h m s	Mean N.P.D. 1870. ° ′ ″
LL.	23 39 41·46	80 55 50·22
B.	41·48	49·07
Gl.	41·48	49·45

The Glasgow N.P.D. results for the several years are—

Year.	No. of Obs.	Mean N.P.D. 1870. ° ′ ″	Corrected for P.M. ″
1870·94	2	80 55 49·77	49·56
1878·78	1	51·14	49·21

Erratum.

Vol. xliii. p. 19, Apparent Declination of Great Comet on Sept. 17, *for* 1° 37′ 25″·3 *read* 1° 27′ 25″·3.